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With METALLURGICAL SUPPLEMENT.

# The Engineer.

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VOL. CLIV.—No. 4016] LONDON: FRIDAY, DECEMBER 30, 1932 [PRICE {WITH SUPPLEMENTS} ONE SHILLING BY INLAND POST 1s. 3d.

## PUBLIC NOTICES.

### University of Bristol.

Convocation of the University of Bristol has appointed a Committee to compile a Register of Past Students (A) of the University; (B) of University College, Bristol; (C) of Bristol Medical School; (D) of the Merchant Venturers' Technical College; and (E) of the Day Training College, prior to incorporation in the University. Past Students of any of these Institutions who have not received an individual invitation to supply the information required by Convocation are asked to assist in making the Register complete by communicating as soon as possible with the SECRETARY to CONVOCATION, University of Bristol, who will furnish them with the appropriate form for completion. 9274

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PATENTS AND DESIGNS ACTS, 1907 TO 1932.

### Notice is Hereby Given that

ERNEST FRASER JONES, of Victoria Station House, Victoria-street, London, S.W., SEEKS LEAVE to AMEND the SPECIFICATION of the APPLICATION for LETTERS PATENT No. 381,790, for an invention entitled "Improved Manufacture of Hollow Ingots."

Particulars of the proposed amendment were set forth in No. 2292 of the Official Journal (Patents), published on December 21st, 1932.

Any person or persons may give NOTICE OF OPPOSITION to the amendment by leaving Patents Form No. 19, at the Patent Office, 25, Southampton-buildings, London, W.C.2., within one calendar month from the date of publication of the said Journal.

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## The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

A Reheating Turbine Installation in Japan. (P. 658)
(With a Two-page Supplement).
THE ENGINEER, 30-12-32

1,500,000 kVA Alternator and Switchgear Testing Plant. (P. 672)
THE ENGINEER, 30-12-32.

Precision Grinding Machines No. XV. (P. 662)
THE ENGINEER, 30-12-32.

Statistics and Engineering—No. IV. (P. 661)
(D. W. WALTON.) THE ENGINEER, 30-12-32.

New Coal-handling Plant at Gibraltar. (P. 666)
THE ENGINEER, 30-12-32.

Boilers and Heat Pumps. (P. 669)
THE ENGINEER, 30-12-32.

Yesterday and To-day. (P. 669)
THE ENGINEER, 30-12-32.

## INDEX TO ADVERTISEMENTS, PAGE 47.

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**FOR SALE (continued) Page 48.**

**AUCTIONS, Page 48.**

*For Advertisement Rates see First Column Overleaf.*

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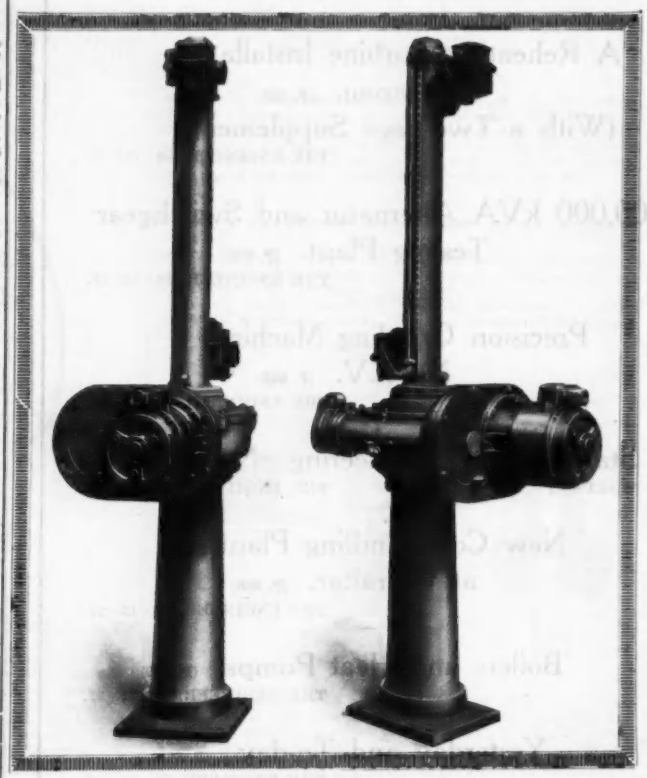

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# A Seven-Day Journal

## High-Pressure Boilers.

IN a paper on Post-war Developments in High-pressure Boilers, read before the I.E.E. by Messrs. C. H. Davy and C. H. Sparks on Thursday, December 15th, the view is expressed that it is improbable that special effect or forced circulation boilers will displace those of the normal type, because they are not so easy to operate and do not appear to offer any advantage as regards price. The power plant engineer, it is explained, requires simplification rather than some small improvement in thermal efficiency at the expense of complication. Whilst the trend, both in Europe and in America, has been definitely towards higher final steam temperatures, the authors believe that these will be limited to about 850 deg. Fah. until such time as the cost of special steels is materially reduced. The demand for high-pressure boilers, it is believed, will continue for power stations, but super-pressure boilers will be mainly limited to industrial work and to the compounding of low-pressure stations where conditions permit. Although Mr. David Wilson described the paper as a catalogue containing nothing particularly new, it will be probably read with interest by many engineers who have been unable to keep in touch with all modern boiler developments. Besides natural circulation boilers of standard types, the paper deals with directly heated forced circulation boilers, indirectly heated boilers, and special effect boilers, including the Atmos. The data presented to show the rate of increase in cost of boilers, superheaters, economisers, and air heaters with rising pressure and increased final temperature and, alternatively with reheat, will probably be widely appreciated by all interested in the design and operation of power stations.

## Industrial Survey of Lancashire.

A BODY called the Lancashire Industrial Development Council has, with the assistance of the University of Manchester, published a report, entitled the "Industrial Survey of Lancashire," which we summarised in a Journal note of August 12th. Certain recommendations contained in the Report have been included in a letter from the Chairman, Mr. T. D. Barlow, to the Prime Minister. The letter suggests that "it would be in the national interest, as well as in the interest of Lancashire, for the Government to adopt as a settled policy the intention to act in matters, both of legislation and administration, on the principle that exceptional measures must be taken continuously so as to direct and influence the channels of industrial development as to lead to some adjustment of the balance of industrial activity between this and other areas not similarly circumstanced." The primary function of the Lancashire Industrial Development Council is the attraction of new industries to this area, and it is claimed that its efforts have yielded some practical results. Certain foreign manufacturers of specialities have been induced to establish plants in Lancashire. One which may be mentioned is an engineering works in Trafford Park, now in process of equipment. The report states that the chief aim of whatever may be done should be to create an inducement to newcomers to outweigh the prejudice on the grounds of a labour supply too much wedded to the old industries and too little adapted to the operations associated with the newer industries. Such prejudice, unfortunately, exists against Lancashire, and other similar areas, but, it is stated, there is little justification for it in actual fact.

## Rural Electrification.

IN dealing with the Bedford rural demonstration scheme, the twelfth annual report of the Electricity Commissioners states that while the results so far attained are of interest to all who are concerned with rural electrification, it would be premature at the present juncture to attempt to draw any general conclusions for application to the development of other rural areas. The full benefits from the policy of rapid construction will only accrue after a further period of intensive methods of development and a reasonable interval must elapse before the effects of the scheme and of all the facilities offered by the Corporation of Bedford in securing, and creating new consumers and extending the use of electricity in the demonstration area can be assessed. Sales of electricity during 1931–32 showed an increase of 1,228,927 units, or over 90 per cent. on the sales in the previous year. The outstanding feature of the second year of working was the large increase in the amount of electricity taken by brickworks. The average revenue obtained from all classes of supply per unit sold amounted to 1·685d. in 1930–31 and to 1·327d. in 1931–32, a reduction of over 21 per cent. The average cost per unit sold of the supply required for the demonstration area in 1931–32 also showed a reduction of 21 per cent. on the corresponding figure for the previous year and from October 1st, 1931, the Corporation made reductions in the charges and tariffs applicable to the Bedford Corporation as a whole, including the demonstration area. The Norwich demonstration scheme is also dealt with, but here, again, it is stated that sufficient time has not elapsed to show the effect of the propaganda and intensive methods of development initiated by the Corporation in the area.

## Swedish World Power Conference.

THE preparatory work of the Organising Committee of the next World Power Conference, which will take place between June 23rd and July 10th, 1933, in Scandinavia, is proceeding steadily and successfully. The first plenary World Power Conference was held in London in 1924, the next in Berlin, 1930, while there have also been Sectional Meetings with concentrated programmes at Basel in 1926 and London in 1928. The Scandinavian Conference will be such a special meeting, dealing with the energy problems of large industry and transport. Participation and collaboration of fifteen countries (outside Scandinavia) has been hitherto assured. More than 170 reports have been so far announced. About forty of the reports to be published at the meeting deal with problems of energy supply in the large-scale industry, such as combined power and heat supply, the *rôle* of the large-scale industry in national power schemes, &c. A considerable number discuss the problems of long-distance gas transmission, which are now particularly prominent in many countries; other papers are devoted to the more special power problems concerning iron and steel industry, pulp and paper, as well as cement, sugar, textile, and the other steam heat consuming industries. Energy questions of transport yield subjects for some sixty-two reports; while railway and marine transport, and the peculiarities of city and suburban traffic will be discussed with due emphasis on the keen competition which electric traction and the oil engine have put up against the steam locomotive. In face of the difficulties of the world situation, there is more need than ever, it is pointed out, for rational planning in industry. The good support given to the World Power Conference Sectional Meeting in Scandinavia shows that technical and industrial circles fully appreciate the opportunity which will be provided for the man of industry to meet the power expert in order that they may discuss common problems and exchange experiences to their mutual advantage.

## The White Combined Engine.

IN our issue of July 29th we described the 520 I.H.P. White combined marine steam engine and turbine, which was demonstrated at the St. Peter's Works of R. and W. Hawthorn, Leslie and Co., Ltd., and was tested by Professor Hawkes. The announcement is made that the Moor Line, Ltd., of Newcastle, of which Sir Walter Runciman is the chairman, has ordered two 8500-ton deadweight capacity cargo ships, which will be engined by White's Engineering Company, Ltd., of Hebburn-on-Tyne, with the new combined turbine and reciprocating units, supplied with steam from oil-fired boilers. The ships are to be built by the Burntisland Shipbuilding Company, Ltd., of Burntisland, Fife, and are to be equipped with the latest type of appliances for the quick handling of cargo. The claims made for the new engine include an increase of speed on the same fuel consumption of 15 to 20 per cent., or, alternatively, the maintenance of present speeds with a reduced fuel consumption of over 30 per cent., there being, in addition, a 25 per cent. reduction in the weight of the machinery. The engines will be the first of their type built for commercial use, and their performance at sea will be awaited with interest.

## Profit-Sharing in Co-operative Societies.

FROM the return issued by the Co-operative Productive Federation we are able to complete our review of profit-sharing in the engineering and allied industries for the year 1931. A summary of the Ministry of Labour's figures dealing with commercial concerns was given in a Journal note in our issue of June 24th, 1932. The present return is confined to the forty-two co-operative productive societies affiliated to the Federation. Of the five societies in the metal-working and miscellaneous industries, four have an engineering interest. In this group the Chesham Builders, Ltd., was the only society making a division of surplus, capital receiving 2½ per cent. and labour 1s. in the £ on wages, the bonuses totalling £19 and £131 respectively. This society, the smallest of the group, had 48 members and a share capital of £803. Its 25 employees took £4225 in wages during the year. Business to the value of £9069 resulted in a net surplus of £275, these figures comparing with £10,711 and £258 for the preceding year. Of the three other engineering societies, the Walsall Locks and Cart Gear, Ltd., is by far the largest. At the end of 1931 it had 340 members and a share and loan capital of £23,934. Its 305 employees received £32,719 in wages and its turnover for the twelve months came to £62,629, giving a net loss of £23. In 1930 the turnover was £77,861, and showed a net surplus of £2819. The Leicester Carriage Builders, Ltd., with 33 employees, a wages bill of £4721, and a turnover of £11,805, turned its 1930 deficit of £288 into a surplus of £212. At the end of 1931 it had 182 members and a share and loan capital of £6133. The remaining society in this section is the Alcester Needlemakers, Ltd., having 141 members and a capital of £3326. At the end of the year it employed eight workpeople, the total wages bill being £1007. Business to the value of £15,299 was done, giving a surplus of £3. Forty-two societies—an increase of one—are included in the Federation's return. Collectively, they had a membership of 15,187, and a capital of £1,076,596; 6974 workpeople were employed and £759,189 was paid in wages during the year.

## The Retirement of Mr. E. T. Goslin.

THE announcement is made that Mr. E. T. Goslin, the general manager of the Clyde Valley Electrical Company, Ltd., has intimated to his directors his wish, for reasons of health, to retire from the company's service at the close of the current year. Mr. Goslin has held the position of general manager of the Clyde Valley Company for the past twelve years, previous to which he was in the service of the Glasgow Corporation Tramways Department for over twenty years, for eighteen of which he was Chief Electrical Engineer. He was born in Ramsgate and began his career in the service of Crompton and Co., Ltd.; later he worked with the Hove Electric Lighting Company and the County of London Electric Lighting Company, after which he was appointed to the electrical staff of the Glasgow Corporation Tramways Department, and carried out important work connected with the development of the Pinkston Power Station. During his subsequent twelve years of service with the Clyde Valley Company the scope of that undertaking was greatly extended, and Mr. Goslin was closely associated with the developments which took place. His many friends, both on the Clyde and in the South, will wish him many years of happy retirement.

## Vancouver Harbour Bridge.

ACCORDING to official information received from the High Commissioner of Canada, we learn that the Vancouver Harbour Commissioners have received authority from the Dominion Government to take over and to operate in trust the damaged Second Narrows Bridge, which crosses the Burrard Inlet and joins Vancouver with the North Shore municipalities. Mr. Edward H. Bridgman, of the Burrard Inlet Tunnel and Bridge Company, has now obtained Court approval to enter into a contract with the Dominion Bridge Company for the rebuilding of the structure. It is understood that the contract will amount to 840,000 dollars and that the structure is to be ready for traffic next spring. The bridge has been closed to traffic since it was damaged over two years ago. In the course of reconstruction important alterations will be made which, it is expected, will eliminate possible danger of accidents from shipping and will facilitate navigation through the Second Narrows. The present bascule span, which is close to the south shore, is to be replaced by an immovable section, while the adjoining fixed span further out will be replaced by a lifting span for its full width of 300ft. The entire section will be lifted horizontally from towers at both ends.

## Coastal Trade Development Council.

AT a meeting convened by Admiral of the Fleet Earl Beatty and Sir John Sandeman Allen, in a Committee-room of the House of Commons on Tuesday, December 20th, it was decided to constitute a Coastal Trade Development Council for the purpose of bringing before the public, the trading community, public authorities, and the Government the national and economic claims of British coastal shipping. In outlining the position, Earl Beatty set out a threefold objective for the Council. Its object, he continued, was to create among the commercial and trading community appreciation of the fact that, though coastwise shipping might be diminished, it was neither decadent nor insignificant. There were, he said, 2400 ships regularly engaged in the coastal trade of Great Britain and 25,000 people employed, exclusive of dock and other part- or whole-time labour. It could, he said, strive to create among Government and local and port authorities faith in the future of coastal shipping, and thereby induce long-overdue improvements in ports and port facilities; it would also endeavour to secure from the Government recognition of coastal shipping as a vital part of internal transport, entitled to equal treatment with other forms of transport. The function of the new body, added Earl Beatty, was conceived as being mainly, if not exclusively, educational, and he therefore did not propose to propound the exact form in which Government encouragement should be given. Such suggestions should more properly come from the industry itself, and the organisation now proposed could most usefully fortify the claims of coastal shipping with the authority of public opinion. The office of the Council is at 23, Breams-buildings, E.C.4, and Mr. J. Page Thornton is the secretary.

## A Reheating Turbine Installation in Japan.

As early experiences with furnace and gas re-superheaters associated with turbine plant presented difficult temperature control problems, a change has been made in many cases to the more simple method of live steam reheating, which, although less advantageous from a thermodynamic point of view, is amenable to automatic temperature control, and involves less initial outlay. With live steam reheating the gain in efficiency is small and the advantage lies mainly in reduction of the steam wetness in the low-pressure turbine stages with consequent reduction in blade erosion. Reheating in any form has made little headway in America, where the tendency has been to revert to the straight cycle, but it cannot be said that this policy is being adopted universally.

An interesting live steam reheating turbine installation, intended mainly for seasonal duties, has been installed in the Sanyo Chuo Hydro-electric Company's station (Fig. 1) at Shikama, Japan, by the Metropolitan-Vickers Electrical Company, which was responsible for the complete installation, including the two-cylinder turbine, alternator, condenser, feed heaters, evaporators, ejectors, and auxiliary motors. The economic rating of the set shown in Fig. 2 is 28,000 kW, the maximum continuous rating 35,000 kW, and the overload capacity 38,500 kW. The speed is 1800 r.p.m.

The initial steam conditions are 600 lb./sq. in. g. at a temperature of 725 deg. Fah., reheating being carried out between the cylinders to 480 deg. Fah. The vacuum at maximum continuous rating is 28 in. with a cooling water supply at 80 deg. Fah.

### Turbine Construction.

As is usual with this class of turbine, the high-pressure cylinder is composed entirely of steel, and consists of a velocity compounded stage followed by nineteen low-velocity impulse stages. In our Supplement we give drawings showing the general arrangement of the set, a general arrangement plan, a part-general arrangement plan at the turbine end of the set, and the details of the low-pressure spindle gland at the inlet end of the cylinder. The gland—Fig. 3—at the high-pressure end is of the maker's axial clearance type, as developed by them for high steam conditions, the stationary part consisting of two groups of steel segment rings carried in two housings which are backed by flat springs, whilst the corresponding rotating elements are formed from solid steel sleeves secured to the shaft. If rubbing should occur, the resulting local distortion of the parts in contact causes the clearance to be increased and the gland resumes its normal setting when the cause of the rubbing is removed. This labyrinth gland is supplemented by a water-sealed gland, consisting of an impeller rotating in a race supplied with condensate. The vapour from this gland is ultimately returned to the condenser. To maintain the correct axial running clearance for the high-pressure labyrinth gland the Michell thrust block at the high-pressure end is capable of finely adjusting the lateral position of the shaft. At the other end of the high-pressure cylinder the gland is of the comb type, with radial clearances, as shown in Fig. 4. While retaining the correct working clearance, it permits of the expansion of the shaft. It consists of two groups of gland rings, each containing four segment rings, the rings and housings being backed by flat springs. This type of gland also possesses the self-clearing characteristics described above. The built-up diaphragms in the high-pressure cylinder have nozzle blades individually machined from solid bars of nickel steel, and provided at the inner end with a slot which fits over a tongue formed on the steel plate centre, to which the blades are securely riveted. Slots are also formed on the outer ends of the blades for the reception of circumferential key strips. When completed, the diaphragms fit into grooves turned in the cylinder casing. A portion of a diaphragm showing the method of assembly is illustrated in Fig. 5. The method adopted is claimed to possess advantages of very high accuracy, which is contributory to high efficiency, and of rigid and robust construction. At the inner periphery of each diaphragm the gland consists of a segment ring similar to those comprising the gland at the low-pressure end of the cylinder. The rotating blades—Fig. 6—are composed of rolled section stainless steel. They have "T"-shaped roots, and register with corresponding grooves formed in the wheel peripheries, the blades being interspaced by means of packing pieces.

### Low-pressure Cylinder.

The low-pressure cylinder of the turbine consists of eleven impulse stages followed by a Metropolitan-Vickers duplex multi-exhaust. Extending to the first six stages the high-pressure portion of this cylinder is composed of steel, whilst the remainder is cast iron. The first three diaphragms in the cylinder are built up, the remainder being of cast iron with cast-in steel blades. The first six rows of rotating blades are composed of stainless steel, and are similar to those in the high-pressure cylinder, whilst the remaining moving blades are of the straddle root type, and are made of 5 per cent. nickel steel. At the inlet end of this cylinder, the gland—

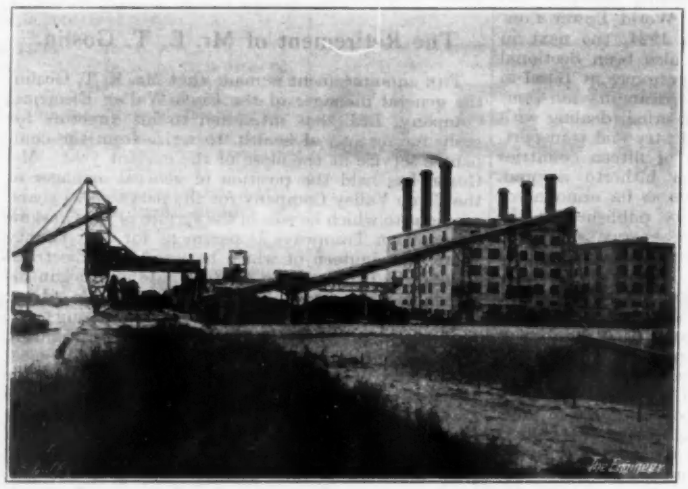


FIG. 1—EXTERIOR OF STATION

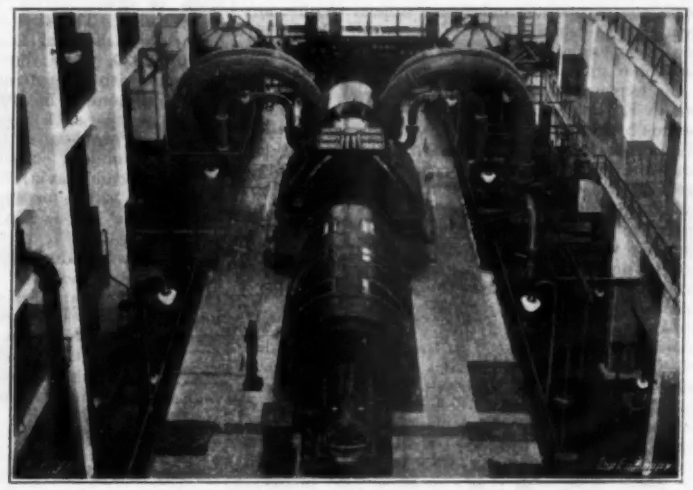


FIG. 2—INTERIOR OF STATION

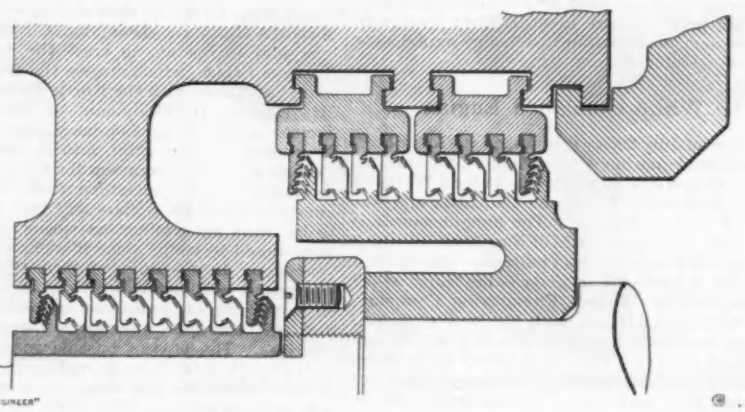


FIG. 3—HIGH-PRESSURE GLAND

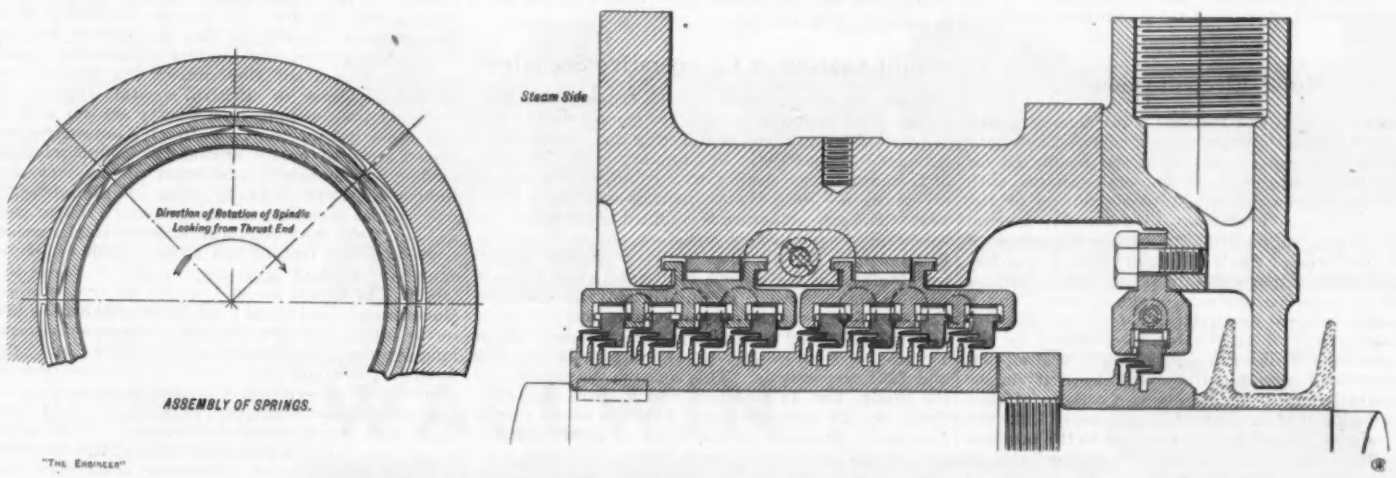



FIG. 4—HIGH-PRESSURE CYLINDER—GLAND AT EXHAUST END

Fig. 7 and Supplement—is of the double comb radial clearance type, arranged in four groups of four segment rings. In construction this gland is similar to that at the low-pressure end of the high-pressure cylinder, but as the proximity of the low-pressure spindle thrust block obviates the necessity to cater for axial expansion, double-sided segments can be employed. At the low-pressure end of this cylinder the gland is of the water-sealed type.

### MAIN GOVERNOR VALVES.

On the steam chest there are two automatically controlled governor valves. One of them supplies

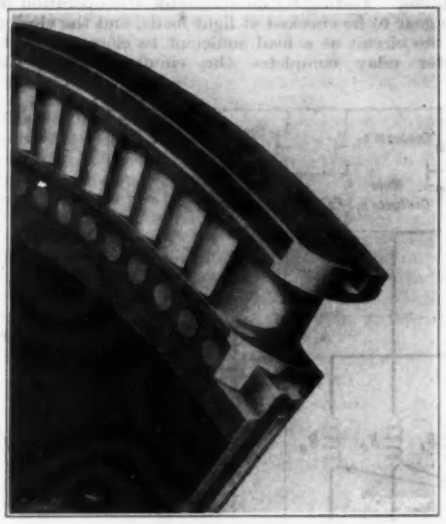


FIG. 5—PART OF DIAPHRAGM

steam to the velocity stage nozzles and deals with loads up to 28,000 kW, whilst the other by-passes the velocity stage and the first four impulse stages, and deals with loads up to 38,500 kW, even when the reheater is out of commission. This corresponds to a volume of steam considerably in excess of the volume at normal load, and in order to improve the consumption between 28,000 kW and 36,000 kW, a hand-operated valve is provided to enable the velocity stage to be by-passed alone, thus admitting steam from the first governor valve direct to the first impulse stage inlet nozzles. The high and low-pressure spindles are coupled by means of a Bibby type flexible coupling, while those of the low-pressure turbine and alternator are coupled by means of a semi-flexible coupling consisting of a steel shell which is flexible in bending but rigid in torsion and is rigidly bolted at its ends to the respective shafts.

### CONDENSER AND AUXILIARIES.

With a cooling surface of 50,000 square feet, the Metropolitan-Vickers central flow condenser is one of the largest units manufactured in this country. The cast iron shell is built up in sections, which are bolted together, and the water-box and end covers are also of cast iron. There are 9710 tubes of 18 S.W.G. thickness, and with an outside diameter of 1in. Sea water at a temperature of 80 deg. Fah. will be used for cooling. The condenser is bolted directly to the turbine exhaust flange and spring supports are provided underfoot on the shell. All the condensate and the make up from the evaporators is deaerated in the condenser itself, thus avoiding the use of separate deaerating plant.

There are two Drysdale motor-driven circulating pumps, each designed for 50 per cent. of the full required capacity, and two Drysdale motor-driven extraction pumps, each capable of performing the full duty independently. After leaving the extraction pumps, the condensate is passed through the coolers of a two-stage Metrovick ejector, in which the latent heat of the ejector operating steam is recovered, and added to the condensate. There are two of these ejectors, and each is capable of the full capacity required. From the coolers of the ejectors the condensate passes to two Metrovick low-pressure and two high-pressure heaters, and also to a gland cooler between the two former heaters for the recovery of the heat of the gland leakage steam. The feed enters the vertical heaters at the top of a divided water-box, and then passes through U tubes and returns to another section of the water-box from which in the case of the four-flow low-pressure heaters, it passes to the next "flow," the high-pressure pressure heaters being of the two-flow type.

The main heaters are supplied with steam tapped from the low-pressure cylinder inlet, after the third, sixth and tenth stages of this cylinder, and the condensate from the third and fourth heaters is cascaded back to the second heater, from which it is delivered by a drain pump into the feed line on the suction side of the boiler feed pump, the condensate from the first heater being passed back to the condenser. The low-pressure heater bodies are made of cast iron,

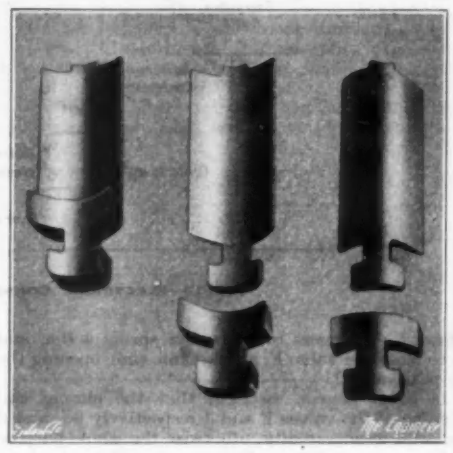


FIG. 6—MOVING BLADES

whilst those of the high-pressure heaters are composed of riveted steel plate. In order to isolate the high-pressure heaters from the feed circuit, in the event of the condensate level exceeding a predetermined limit, suitable automatic devices have been provided for the purpose, and the possibility of the turbine being flooded from the steam side of the heaters is thus avoided. In the feed system between the first and third heaters, Metrovick double-effect, low-pressure, straight-tube evaporators have been incorporated, and the make-up from both units is collected in the first heater, from which it is passed back to the condenser where it is completely de-aerated before removal by the extraction pump.

The evaporator shell is formed of welded steel, and an important feature of the design is that, apart from a short length at each end, the tubes are oval, a feature which is claimed to facilitate the quick release of the vapour generated and to reduce turbulence at the surface of the make-up water. Packed ferrules are provided at each end of the copper tubes, and those at one end are designed to permit of the easy withdrawal of the tubes. Above the normal make-up level there is a single row of tubes which constitute a "hot plate," or drying tubes, for evaporating the make-up in suspension, whilst, in order to remove any residue of suspended make-up, the domes of the evaporators are provided with a system of separator baffles.

### REHEATERS.

Live steam reheaters, which were made in Japan, are arranged on opposite sides of the high-pressure cylinder, as shown in one of the plans in our Supplement. Each of the two vertical shells of the two evaporators is 26ft. 6in. long and 8ft. 3in. in diameter; the high-pressure steam tubes have an outside diameter of 1¼in. and are 0·144in. thick. The low-pressure steam enters at the base, and after passing upwards across the high-pressure coils, returns to

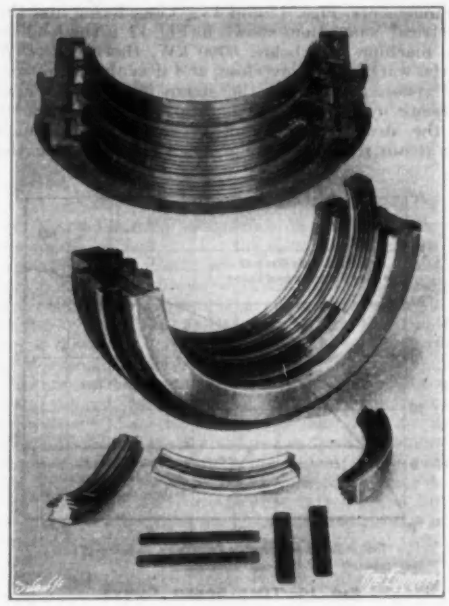


FIG. 7—DOUBLE COMB TYPE GLAND

the outlet at the other side of the base behind a vertical baffle plate. The piping was made by Aiton and Co., Ltd., of Derby. In designing the pipe connections to and from the reheaters care was taken to provide ample flexibility and to reduce the length of the low-pressure piping to a minimum.

### OPERATION OF REHEATER GEAR.

In two-cylinder reheating turbines, with the reheater between the cylinders, the large volume of steam contained in the reheater and pipe connections is beyond the control of the governor valve, and in the event of a sudden drop in load the pressure of this steam may be sufficient to speed up the turbine to an undesirable extent during its passage through the low-pressure cylinder to the condenser. The protective system which has been adopted in the case under consideration was evolved by the Metropolitan-Vickers Electrical Company. In the event of the load falling below a predetermined amount in advance of the drop in pressure in the reheater connection, the reheater is automatically isolated from the low-pressure cylinder, and the steam in the reheater is by-passed directly to the condenser. Simultaneously, the closing action of the main governor valve is automatically accelerated. After a suitable time interval, during which the pressure in the reheater has had time to drop to a safe value, the system automatically resets itself and permits the main governor valve to reopen and the steam to follow its normal path. The by-pass mechanism operates when the following conditions are fulfilled:—

(a) When the load on the alternator drops below

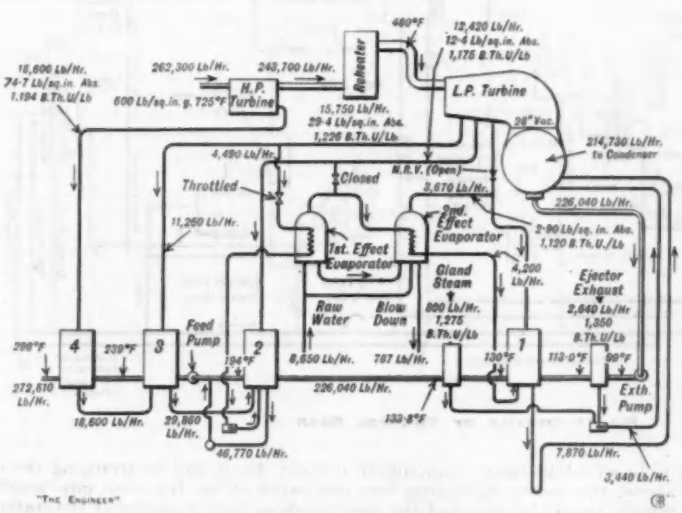



FIG. 8—ECONOMICAL LOAD HEAT BALANCE DIAGRAM

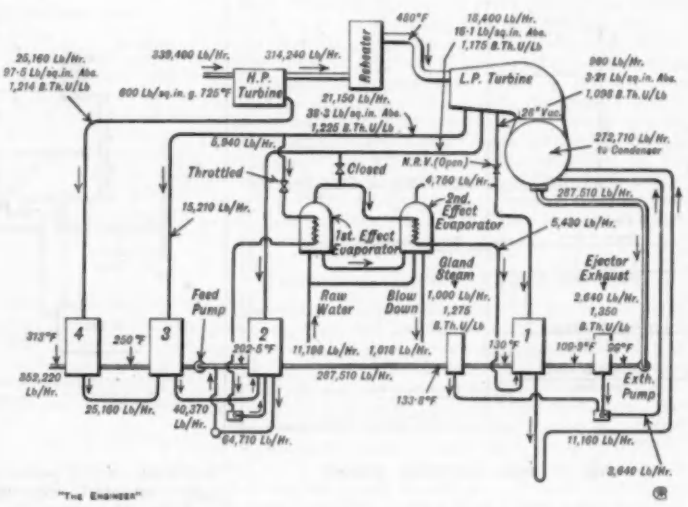



FIG. 9—MAXIMUM CONTINUOUS LOAD HEAT BALANCE DIAGRAM

approximately 6000 kW, and (*b*) when the steam pressure at the inlet to the low-pressure cylinder is too high for that load, *i.e.*, at or above 13 lb. per square inch gauge, this pressure corresponding to a load of 9000 kW and giving an overlap of 3000 kW. Hence, it will be seen that the system provides protection against overspeed arising from any sudden decrease of load, but it is inoperative in the event of a gradual decrease of load which will lower the intermediate steam pressure.

### MAIN AND REHEATER GOVERNOR SYSTEMS.

The action of the main and reheater governor systems will be understood from the diagrammatic arrangements, Figs. 12 and 13. Considering first the electrical connections shown in Fig. 12, if the load on the machine falls below 6000 kW, the contacts W of the wattmeter relay close, and if at the same time the steam pressure at the steam inlet to the low-pressure cylinder is 13 lb., or over, the contact H of the steam relay completes the circuit through the steam relay energising coil A, thus causing the

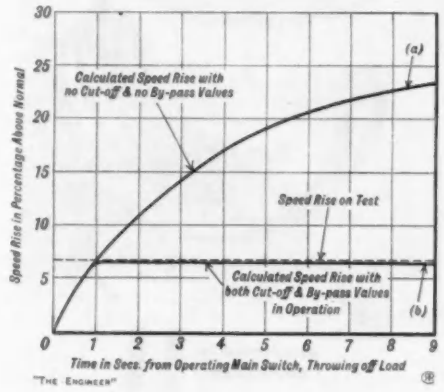

Calculated Speed Rise with no Cut-off & no By-pass Valves
(a)
Speed Rise on Test
Calculated Speed Rise with both Cut-off & By-pass Valves in Operation
(b)
Speed Rise in Percentage Above Normal
Time in Secs. from Operating Main Switch, Throwing off Load
"THE ENGINEER"

FIG. 10—TIME-SPEED CURVE

contacts $a_1$ in the steam relay circuit, and $a_2$ in the wattmeter relay circuit to close. Current thus flows through the auxiliary contactor coil B, which actuates the main contacts $b_1$, and permits the flow of energising current to the operating solenoids $S_1$, $S_2$ and $S_3$. When the pressure at the point in question falls below 13 lb. gauge, the steam relay contacts open, but as the circuit through the coil A and contactor $a_1$ is not broken, the solenoids remain energised. But when the pressure falls to 9 lb., the alternative contacts L in the steam relay close, and, in short circuiting the coil A, open contacts $a_1$ and $a_2$, which de-energises the solenoids.

The solenoids are energised when the load is below 6000 kW and the steam pressure is 13 lb. gauge or

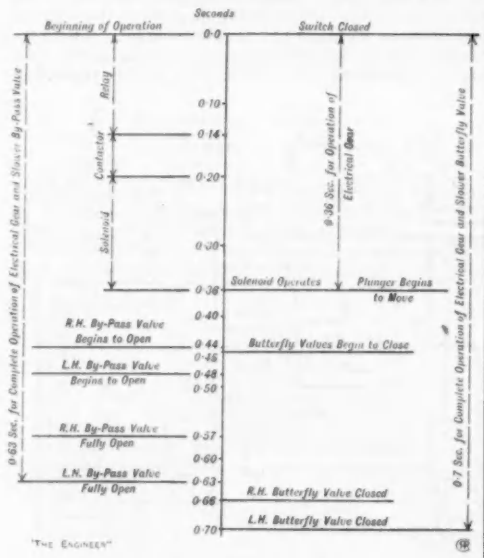

Seconds
Beginning of Operation
Switch Closed
Relay
Contactor
Solenoid
9·36 Sec. for Operation of Electrical Gear
Solenoid Operates
Plunger Begins to Move
R.H. By-Pass Valve Begins to Open
Butterfly Valves Begin to Close
L.H. By-Pass Valve Begins to Open
R.H. By-Pass Valve Fully Open
L.H. By-Pass Valve Fully Open
R.H. Butterfly Valve Closed
L.H. Butterfly Valve Closed
9·63 Sec. for Complete Operation of Electrical Gear and Steam By-Pass Valve
9·7 Sec. for Complete Operation of Electrical Gear and Steam Butterfly Valve
"THE ENGINEER"

FIG. 11—TIME INTERVAL CHART

over, and become de-energised when the pressure falls below 9 lb. gauge. In order to prevent the solenoids becoming de-energised if the machine is running above normal speed, contacts *d* mounted on the main governor, complete a circuit through coil C, which, in turn, closes contacts $c_1$, and allows a current limited by resistance $r_3$ to continue to flow through the solenoids. This current is sufficient to maintain them in their raised position, but insufficient to operate them if the main contacts $b_1$ are opened, and only the governor arm contacts *d* are closed.

Red signal lamps brought into circuit by the energising of contactor coil B and the closing of contacts $b_2$ are fitted on the main control board to notify the attendant of the operation of the gear.

Coming now to the mechanical portion of the gear —Fig. 13—during normal operation of the machine, the steam valve F is maintained in the open position by oil pressure acting below the piston in the cylinder G. Similarly, the valve J is normally maintained in the closed position by a piston in the cylinder K, the oil to both cylinders being supplied from the oil pump, and is controlled by the pilot valve M. In the event of a sudden fall in load beyond the predetermined limit, with a corresponding excess of pressure in the reheater, the operation of the wattmeter relay and pressure relay described, causes the solenoids $S_2$ and $S_3$, Fig. 12, to become energised. As two reheaters are employed—one on each side of the turbine—the whole of the by-pass gear is duplicated, solenoid $S_2$ operating the gear shown, and solenoid $S_3$ operating similar gear on the opposite side of the plant. The movement of the armature in $S_2$ raises the valve M, and by connecting the underside of the power pistons in cylinders G and K to a drain,

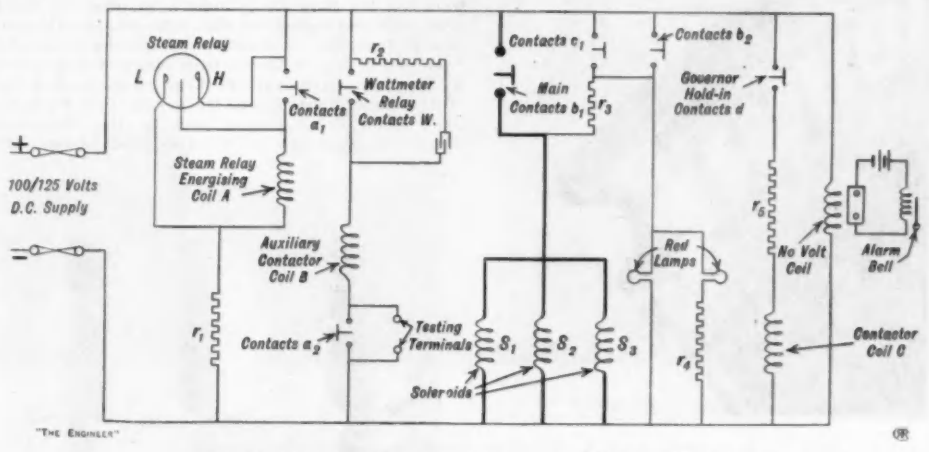



FIG. 12—ELECTRICAL CONNECTIONS FOR CONTROL GEAR

allows the plungers to fall under spring action and so to close the valve F, at the same time opening the by-pass valve J.

It is, of course, essential that the closing and opening of the valves F and J respectively be carried out with great rapidity, otherwise the whole purpose of the gear is nullified. Hence, a special rapid release valve H is fitted to the cylinders G and K, and to the corresponding valves on the other side of the plant.

The oil admitted under pressure through the medium of the pilot valve M is led below a piston housed in the valve H and raises it against spring tension until ports are brought into alignment, and so allows the oil to enter the cylinder G. The piston is thus maintained in its raised position during normal operation of the plant. The release of the pressure by the piston valve M causes the piston in the valve H to fall and so connect the

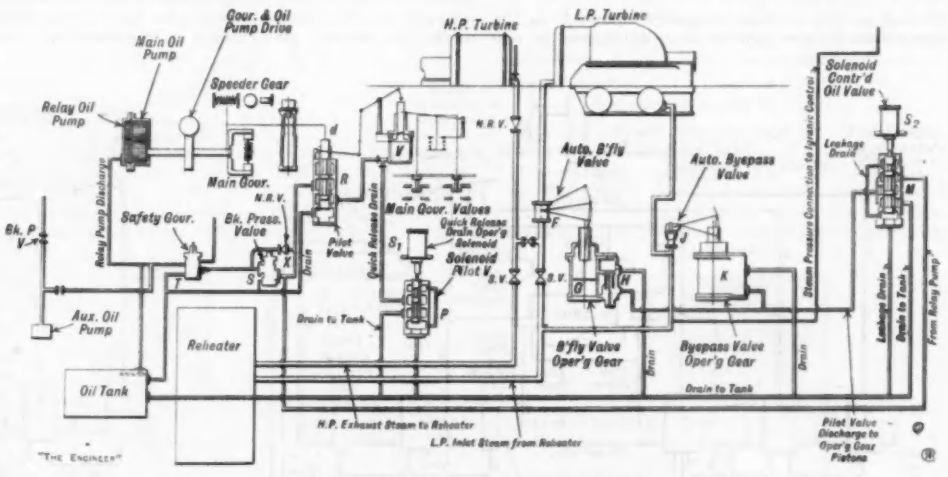



FIG. 13—DETAILS OF CONTROL GEAR

underside of the power piston G to an oil-discharge space situated immediately above the valve H, and into this space the oil is rapidly passed by the spring acting on the power piston. The oil discharge is then much more rapid than if it took place through lengthy oil drain piping. Simultaneously with the operation of the gear following that of $S_2$ and $S_3$, the solenoid $S_1$ raises the valve of the pilot P and releases the oil pressure below the main steam governor power valve V, thus causing it to close rapidly.

It is necessary, however, to prevent this drop in oil pressure extending to the overspeed governor trip valve, for otherwise the latter would operate and shut down the plant. In the absence of proper arrangements this action would be possible on account of the sympathetic upward movement of the main governor pilot valve as the main governor valve falls. To prevent this trouble arising, however, a sensitive back-pressure valve S—Fig. 13—is incorporated and closes immediately the pressure drops below that of the relay oil pump, thus isolating the latter from the reheater relay gear.

In the event of overspeed sufficient to cause the overspeed governor to operate and so actuate the oil trip valve T, it becomes necessary to ensure that the back-pressure valve S does not maintain the pressure below the governor valve power piston, and for this purpose a non-return valve X is included in the system to allow oil to by-pass the valve S and so close the main governor valves. In the event of a failure on the auxiliary electrical supply the operation of a no-volt relay brings an alarm bell into operation and thus gives the attendant audible warning. Testing terminals enable the operation of the gear to be checked at light loads, and the closing of the circuit at a load sufficient to close the wattmeter relay completes the circuit through the auxiliary contactor coil B, thus closing the contacts $b_1$ and energising the solenoids.

The curve *a*, Fig. 10, shows the calculated speed rise with a load of 35,000 kW suddenly thrown off, while the lower curve *b* shows the calculated speed rise with the cut-off governor mechanism in operation and based on 0·7 second for the time of operation of the gear. The dotted line indicates the actual speed rise obtained on a test on site with the same load thrown off. The actual time taken for this maximum speed rise was not measured, but it will be seen that the maximum rise in speed with a load of 35,000 kW thrown off was 6·7 per cent.

The details of the time intervals of the operations involved in the functioning of the various parts is shown in Fig. 11, which represents the result of a test carried out on the gear at the manufacturers' works. The actual site conditions were reproduced in every detail, and in arranging the oil piping care was taken to use the same pipe lengths and the same bends as those required at the station. It will be seen that the time taken from the closing of the switch corresponding to the wattmeter relay contacts, to the complete closing of the last butterfly valve was 0·7 seconds. As the gear was designed to operate over a voltage range of 100 to 125 volts, it was decided to test it at the minimum value, as this would give a result under the worst conditions, the rapidity of operation of the gear naturally tending to increase with a high voltage. Actually the works tests were carried out at 99 volts and the results obtained were those shown. Heat balance diagrams for economical and maximum continuous loads are given in Figs. 8 and 9.

### ALTERNATOR.

The 28,000-kW, three-phase, 60-cycle, 11,000-volt, 1800 r.p.m. alternator has a fabricated steel case

and a concentric type stator winding, the conductors being of the Metropolitan-Vickers transposed type, giving free thermal expansion. A solid steel forging weighing 45 tons constitutes the rotor, which was subjected to special tests to ensure uniform soundness of the material. The method employed in the Metropolitan-Vickers works when making this test consists in creating a magnetic field tangential to the surface under inspection and then washing the surface with paraffin in which finely divided iron powder is suspended. The adherence of the powder to the edge of even a minute crack makes the latter easily visible. The method is applied to the rotor surface and to the bore, a specially designed periscope being employed in the latter case. An efficient system of ventilation in which the air is admitted into special slots arranged below the winding slots and in which a large number of holes drilled radially in the rotor teeth communicate with the longitudinal fan slots, ensures that there is no undue heating.

The overhung exciter has a radial commutator, and to meet the specified high degree of stability, stability plates of cobalt steel have been incorporated in the magnetic circuit. The alternator is ventilated in accordance with the makers' closed circuit system. Fans mounted on the ends of the rotor deal with 40,000 cubic feet of air per minute, while a separate motor-driven fan deals with a further 40,000 cubic feet per minute. The two Metrovick coolers consist of cast iron water boxes with banks of finned brass tubes between them with a total cooling surface of 13,750 square feet.

## Statistics and Engineering.

By DUDLEY W. WALTON, F.S.S.

No. IV. (*Conclusion*).

### Statistical Control of Production.

ADVANCES in statistical practice during the past decade make it possible to apply statistical methods to the control of productive and other industrial operations. The process has been chiefly developed by Dr. W. A. Shewart, of the technical staff of the Bell Telephone Laboratories, and is due to the work of sundry German and American statisticians.

In respect of a large class of engineering operations it is almost axiomatic to say that we can predict the future from past experience; but in all matters of forecasting there is an element of chance. Predictions, when attempted, should be defined within the limits of a margin of error. When something happens contrary to expectation we attribute to "chance" the unknown cause of the abnormal event. By using statistical methods the engineer can isolate, or at least can more easily detect and classify, the abnormal occurrences, and can sometimes foresee them.

The range of such prophetic operations can be exemplified. The time and situation of an eclipse can be calculated many years in advance. The result of tossing a coin one thousand times will give results which are the same to-day as they were in the past, and will be in the future. But who can foretell what will be the price of tin in ten years' time? In calculating the eclipse all the dominant causes have been isolated completely; in tossing the coin the law of large numbers operates, and the residual of variation due to chance is determined within a plus or minus correction. In the case of the price of a metal we can say that there is some system of chance in operation, but it defies analysis. Thus, in addition to computed mathematical *a priori* probability, which is mainly marking paper with symbols, the theory of probability can be applied to real events recurring under the same essential conditions. Some probabilities are independent of time; in others the character of the chance system can be determined within limits; and there are others in which chance is simply "direction we cannot see." The best that can be done with a pure chance system is to obtain some measure of our belief of its entity and range of action.

### Statistic Concept of Tolerance.

By way of illustrating the methods of statistical control take the case of a production process which requires (*a*) procuring raw material; (*b*) fashioning it into parts; (*c*) assembling the parts; and (*d*) completing the finished article. Even when every step in production is rigidly specified, some of the raw material will vary and escape the vigilance of physical or chemical examination; some of the parts will be faulty; some of the assembled units will be ill-adjusted; and some of the finished articles defective. There are possibilities of economic wastage at every step, for there are no "exact constants" in production processes. There are errors of specification with all kinds of operations, and with the very best specification the properties of material will vary within some range. Accidental fracture proves that perfect homogeneity of material is impossible. The personal equation will enter into the work of examiners and shift the standard of inspection, the tolerances set for the parts may be too loose or too rigid; physical fatigue or psychological conditions lead to inefficient assembly; and the final inspection may be too generous or too exacting. With each operation there is some range of variation from high to low which can be or must be tolerated in that operation.

In cases where physical properties of material or tolerances of fit are already established by working conditions the limits of variation are set forth by authority, that is, by the opinion of some experienced person. To-day many limits can be determined by statistical processes. For example, if statistics are compiled of a series of tests it will be found that errors and rejections fall into some system of either assignable or chance causes, and this classification is itself a step towards the elimination of imperfections. If the errors encountered are expressed as percentages of the output, it will be found that they tend to fluctuate around a mean value. These fluctuations can be shown on a relatively simple form of graph and excessive variations detected. For instance, suppose that for a successive series of days the percentage of rejections of a specified part are as shown in Fig. 7. The mean is determined and indicated by the heavy line. What is known as the standard deviation is also determined and is shown as a plus or minus difference from the mean by the long-dotted lines. The short-dotted lines above and below indicate the range of twice the standard deviation. During the first ten days the fluctuations are within one standard deviation; from the eleventh day onwards excessive fluctuations occur, and they were heralded by the marginal percentage on the ninth day. Certainly, by the twelfth day, the supervisor, had he plotted the graph, would have been warned of some abnormal

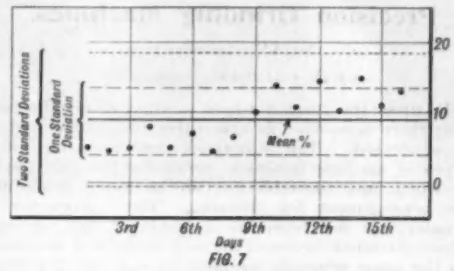



FIG. 7

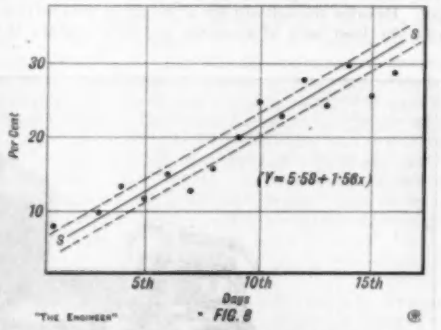



FIG. 8

DOT CHARTS OF DAILY FLUCTUATIONS

variation due either to assignable or chance causes, as, for instance, to a change of temperature. Some wide fluctuations may arise from circumstances external to the operation, as when a rainstorm affects the quality of water used in a grinding operation.

Thus, in setting tolerance limits for the rejection of parts it could be laid down for the guidance of supervisors that the percentage of rejections shall not be allowed to fluctuate, without inquiry, beyond limits determined by one standard deviation.

### Standard Deviation.

This method of setting out data and referring it to the standard deviation of quantities from the mean is the essential method of statistical control. The standard deviation (for which the Greek letter $\sigma$ is the symbol) is the mathematically probable range of variation of sample measurements, and is calculated from the formula $\sigma_x = \sqrt{\frac{\Sigma x^2}{n}}$, where $x$ represents the variation from the mean, $x^2$ the square of each deviation, $\Sigma x^2$ is the sum of all such values, and $n$ is the number of samples. An example was given in the second article of this series (THE ENGINEER, December 16th).

In Fig. 7 it is assumed that one standard deviation is a permissible range of fluctuation, and is therefore the tolerance limit of the range of fluctuation of the percentages of the rejections. Economic considerations might dictate some larger or smaller limit, but it would be comparison with the standard deviation which would determine whether or not any such modified criterion could be applied. A range of two standard deviations, as shown by the dotted lines, might be admissible, in which case all the samples would have come within the limit of tolerance. With a sufficient number of samples there is a very high degree of probability that the extreme range of variation in homogeneous material will not exceed three standard deviations. Tables are available to calculate this kind of probability for various numbers of samples.

### Use of the Line of Least Squares.

It may happen that fluctuations, when charted, have a discernible upward or downward trend. Fig. 8 is a spotted graph of the values of a series of rejections (or other phenomena) where it has been possible to calculate and construct a line of least squares (S) and on either side of this line is shown a zone of one standard deviation from the linear values. This line of least squares becomes a reference line for statistical control in the same way that the mean line in Fig. 7 was a reference line. In Fig. 8 the black dots outside the limits of the zone of standard deviation indicate occasions for investigation into assignable causes of variation.

The formula for calculating the line of least squares involves the solution of simultaneous equations, the line being drawn from the equation $Y = a + b\,x$. The values of $a$ and $b$ are calculated from

$$a = M_y - M_x,$$

$$b = \frac{\Sigma\,(X\,Y) - n\,M_x\,M_y}{\Sigma\,(X^2) - n\,(M_x)^2}$$

where X and Y are the values recorded (as in ordinary cartesian co-ordinates), M is the corresponding mean, and $n$ is the number of items. In practice $b$ is determined first. Examples of working are found in any statistical textbook. There is an engineering example, fully worked out from actual data, of the speed and stopping distance of motor cars in Ezekiel's "Methods of Correlation Analysis," pages 56–64.

The line of least squares when drawn among a series of points is such that the sum of the squares of the variations from the line is at a minimum, or, in other words, the slope of the line has been influenced with equal weight by every one of the variable quantities. A line of least squares defines a tendency to change, and has the advantage of being straight; but it is admitted that it is an empirical instrument of comparison because one cannot infer the ideal trend except from ideal observations. Only in exceptional cases would data derived from workshop observations be sufficiently exact for idealised treatment. It is a property of a line of least squares not to permit of extrapolation. If greater refinement be desired an attempt can be made to fit to the measurement one of the geometrical curves for which formulæ are available. Such attempts at refinement in industrial operations are often illusory. They assume relationships between measurements which either do not exist in fact or, if computed from observations, are contaminated with inaccuracies. One reason why excessive refinement is statistically fallacious is because physical constants are not mathematical relationships, but are just statistical estimates from samples of experience. A fusing point, for example, is not only subject to errors of determination, but the phenomenon itself appears to be variable.

### Assignable Causes of Variation.

A system of assignable causes may be so close to the idealised "constant" form, as in calculating an eclipse, that the chance causes are at a minimum. A system of chance causes may approximate so closely to a recognisable statistical form (such as a curve) that limits of its variability can be fixed statistically. When there is a dual state of assignable and chance causes found in a group of observations, forecasting and statistical control are possible because the assignable causes can be defined, the chance causes isolated, and their range measured. When no system of assignable causes exists or is inferable, custom may dictate a purely empirical line of action, as, for instance, when utilising the personal skill of a foundryman who may be helped by a pyrometer reading, but who, nevertheless, depends upon empirical procedure to produce a satisfactory casting.

### Statistical Control in Engineering.

The *modus operandi* of statistical control involves grouping of operations and possibly regrouping until it is found that each group is distinguished in its behaviour from other groups. If the percentages from adjacent operations make a similar graphic pattern in respect to the standard deviation, the causes, whether assignable or not, have a mutual relationship, and consequently have not been isolated from each other. Grouping isolates phenomena which are not really connected. Thus in a series of manipulations the quality of an alloy may account for error A and in the next operation careless machining may account for error B. If there are twenty parts in an assembled unit, the figures of the percentages of rejections of each of the parts can be studied. If the resultant graphs all exhibit a similar pattern, there is a strong presumption that the cause of failure is something that happened to the material before any of the parts were made.

A second step in statistical control is the determination in each group of the limits of the deviations observed, and the sorting out of the deviations which have a constant range, and those which may belong to some chance system. Naturally a control quality must be one that varies, and the more extreme variations are those which call for the closer study. If the percentage of rejections were constant, it would point to some general controlling cause, or to some

* No. III. appeared December 23rd.

unalterable "law" of relationship. To gain control of the situation—that is to say, to improve the output or to secure some other economic advantage—the investigator would have to go back to the general cause or to the "law" itself. If the master clock at Greenwich showed a constant error, it would be the clock itself, as an assembled unit, that contained the assignable cause, and it could not be, say, due to a variation of temperature. Whenever, then, in any group, variations are observed to be within limits, combined with other variations which exceed the standard or other unit of deviation, the group as a whole has a quality of controllability because the excesses can be identified and examined.

If all the errors in a succession of groups fall in the same direction (plus or minus), there will be a maximum variation in the final product. Otherwise some positive defects will statistically cancel some negative defects. If the variability is reduced, as a result of analysis, to a minimum at each stage, the final variability of the assembled unit will be at a minimum also. Thus when the engineer is assured that successive operations are conducted under control conditions, there is less need, and consequently less expense, for continuous testing, and especially for tests to destruction. When a state of statistical control has been reached the production engineer can distinguish between the variations that can (or must) be left to chance, and those which can be controlled in the interest of efficiency and economy. Every system of tolerance has been brought about empirically from experiences which can now be recognised as suitable for statistical analysis.

The engineering statistician can attempt prediction when causes are assignable, or even when they are largely attributable to some chance system. He can at least sort out the assignable and non-assignable causes of error and defect, calculating the probable range of their operation. There are empirical "laws" of behaviour observable among the members of a homogeneous population. A persistently limited range of variability has itself the quality of being a "constant," and when detected and determined can be compared with the less persistent variables. In this way one can analyse out within the same set of variable observations those which belong to different systems of chance; for instance, the statistician could isolate the residuals which have come over from the tolerances allowed in the previous group, and thus, if desirable, could change the limits of the previous tolerance.

Thus in the data behind Fig. 7 the dots below the mean line might be assignable to a defect in the previous operation. They could be controlled by going back and changing the procedure at the previous stage. In such a case the fractional quantities above the mean could be assumed to belong to some other system of causes.

All chance systems of causes are not alike in the sense that they enable the future to be predicted from the past, but it is known that relatively "constant" systems of chance exist and can be isolated. Refined statistical methods have been developed for this purpose. Fluctuations can be left to chance without attempt to control or eliminate them when a chance system occurs and when no single cause in a group of operations appears to have a predominating effect. A bar of metal is never perfectly homogeneous, and when the use of some alloy is specified and tests show a regular range of variation in behaviour, the range of variation can be accepted as inevitable with that particular alloy. To reach control conditions, one would experiment with a different alloy. Thus the concept of tolerance as commonly applied to dimensions can be extended to include a concept of the tolerance of a range of variations of any physical property.

### Approximation to the Ideal.

With an ideal shop, using ideal material, with ideal machines, and ideal workmen, the percentage of rejections following tests would be zero. How far management should aim at an approximation to zero rejections or perhaps to some very close approximation to the mean is a question of production economics. Losses and delays due to rejections can be valued in the terms of expenditure, and the amount set off against the cost of more rigid selection and refinement of raw material, the cost of eliminating defects, or the cost of remedying them. Hence, if economic to do so, assignable causes of production defects can be controlled and eliminated to secure any predetermined ratio between economic and engineering ideals. In other words, we leave things to chance when it is economic to do so (and when we know on statistical grounds that this is so), and at the same time pursue the attempt, along lines indicated from the statistical analysis to approximate to the engineering ideal.

When variations of output are found to be measurable as a frequency function; that is to say, when correlated elements of constancy are found to exist along a line of productive operations, it should be possible to establish new and improved procedure, either by changing the grouping, redesigning the parts, setting more suitable tolerance limits, or computing new factors of safety. The statistical analysis will guide this planning. The new tolerance limits might be established, for instance, either to effect economies by greater liberality or to secure greater efficiency by increased rigidity. In the same way a new sampling method and technique can be instituted. If economic policy permits, say, 1 per cent. of rejections at the final stage, this ratio can be statistically controlled by sampling at various stages so as to secure the maximum of refinement at the final stage. There would be obviously some determinable tolerances allowable at previous stages which would keep the final rejections within 1 per cent.

Progressively, therefore, by means of statistical control in successive engineering operations, one can isolate assignable causes of defect, admit or eliminate the chance influences, and reduce the incidence of variability. The engineer is thus more and more able, with the aid of statistics to achieve his purposes and enter into that modern realm of conscious evolution.

The doctrine of evolution, in its broadest sense, postulates a changing universe, in which no values can be finally fixed. Physical constants, as observed or computed, are not truly constants, but are frequency phenomena which vary within limits, and these variable elements and properties of the physical world, whether recognised or not, whether measurable or not, set limits to the procedures of engineering. Because of a changing universe of physical material, and because of the progressive enlargement or restriction of engineering concepts, the ideal is unattainable; but assuming some basic tendency to an asymptote, at least provisionally as a symbol of the secret operations of Nature, statistical studies of engineering data bring an increasing range of operations under closer and closer control.

## Precision Grinding Machines.

No. XV. (*conclusion.*)*

### GEAR GRINDING (*continued*).

Besides the formed wheel method of grinding a gear there is another in which the form of the teeth is generated. The difference between the two types of machine is almost complete, the only part in which any resemblance can be found lying in the arrangement for indexing. The "generator" grinder was developed as a result of the success which attended the use of the rack cutter and operates on the same principle modified to suit the grinding wheel. Besides the advantage of being in geometrical theory the best way of grinding a perfect tooth, the method is also applicable with slight modification to the grinding of the helical gears used nowadays in so many transmission systems, whereas it is difficult to perform such grinding with a formed wheel.

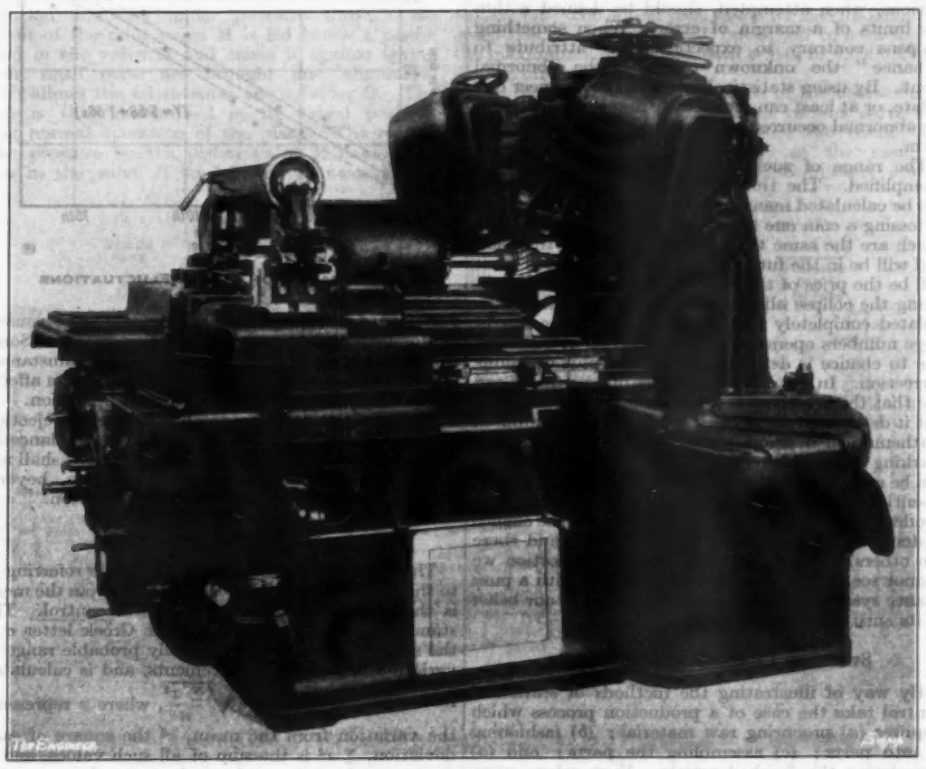


Fig. 112—Maag Helical Gear Grinding Machine

### A "Generator" Gear Grinder.

The machine illustrated by the tone engraving, Fig. 112, is made by the Maag Gear-Wheel Company, Ltd., and marketed by Sulzer Brothers, Ltd., of Bedford-square, London. It is suitable for grinding helical gears up to 8·6in. in diameter, and of a maximum circular pitch of 4·2 D.P. The maximum width of gear accommodated depends to some extent upon the helix angle, the number of teeth, and their pitch, but is in the neighbourhood of 6·7in. The main features of the machine can be seen from the engraving. As in the generating gear cutter, the wheel to be ground is rolled beneath and across the grinding wheels. Instead of using one grinding wheel trimmed to have a shape in section like the tooth of a rack, two wheels independently driven by 0·3 H.P. motors, are used, in the manner shown in the sketch, Fig. 113. Each wheel is of a saucer-like shape, and it will be appreciated that the cutting edge of the saucer revolves in a plane. If the two wheels were both operating in the same tooth space, the angles between the planes traced out by the edges of the two saucers would be that of the corresponding rack. Actually, the wheels operate in adjacent spaces. A saucer-shaped wheel was adopted because it was found difficult using flat-sided wheels to keep the sides plane surfaces, whereas the edge of the saucer is easily maintained and wear is readily compensated for by an axial movement of the grinding head. The two wheel heads, it will be observed, are so mounted as to be capable of axial, angular and vertical adjustment. In addition the column carrying both grinding heads may be set over to a maximum of 45 deg., to suit various helix angles. This adjustment is, of course, not required on machines only capable of grinding spur gearing. In operation the gear to be ground is mounted upon a mandrel and given two motions, one rapid and the other slow. It is fed slowly longitudinally along the machine under the wheels, and at the same time it is reciprocated back and forth across the machine rapidly. This latter motion is combined with a rolling action identical with that which it would obtain if it was in mesh with a rack. The rate of cross reciprocation may be as high as 200 per minute, while the longitudinal feed is continuous and may be at any of eight rates between 1 mm. and 3 mm. per stroke. At the end of the longitudinal motion, when the gear has passed right under the wheels and is free of them on the further side, the indexing mechanism comes into play and rotates the gear by one tooth space, and the cycle is so repeated until all the tooth flanks have been ground. The cross reciprocation, feed and index motions are all operated by a 1 H.P. motor.

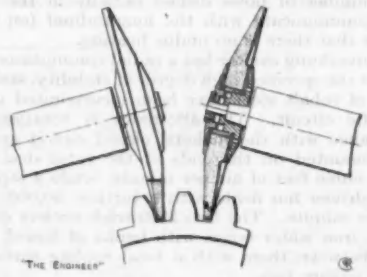


Fig. 113—Arrangement of Grinding Wheels

### The Generating Motion.

The generating motion—that is, the "roll" of the gear as it is cross-traversed—is controlled by the

* No. XIV. appeared December 23rd.

band and sector mechanism, to be seen in Fig. 114, where it is being adjusted by the operator. The diagram, Fig. 116, indicates how the mechanism operates. A shaft C in the bed of the machine is driven by the main motor through a cone pulley A and a worm and wheel B. By means of a belt and a Lenix pulley the motion of the shaft C is transmitted to a crank disc E, the crank pin of which runs in guides F on the main cross-slide of the machine. In this way this slide is given a rapid cross-reciprocation. The pitch-block, or sector, H, is fitted on a shaft J carried by the slide, and is in connection with the mandrel upon which the gear to be ground is mounted. Two steel bands G connect the pitch-block to fixed points on the bed, so that the shaft J is given the necessary rotary motion

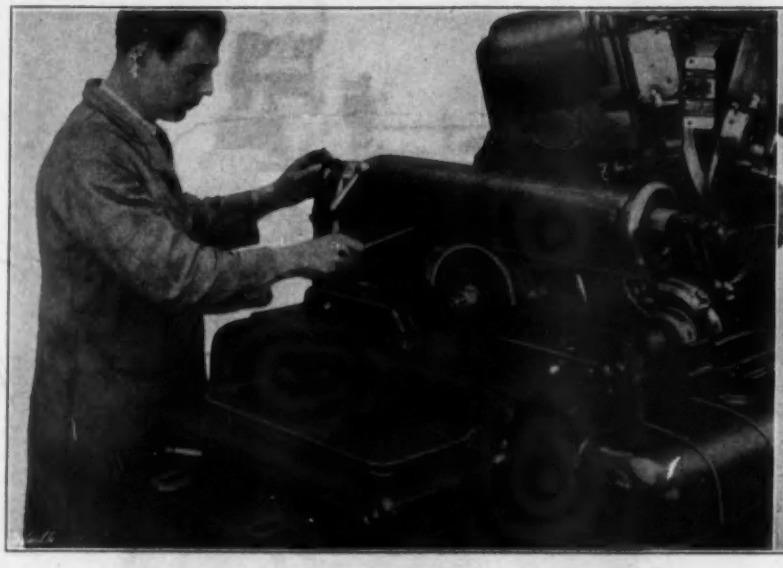


FIG. 114—PITCH BLOCK AND BAND AND SECTOR MECHANISM

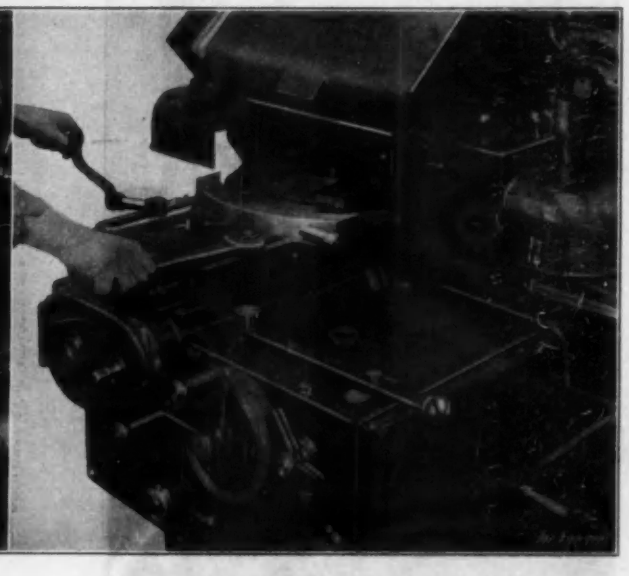


FIG. 115—ADJUSTING GUIDE TO SUIT HELIX ANGLE

as it reciprocates to and fro. This motion alone is sufficient for grinding the straight teeth of spur gearing. But for helicals the gear must be given an additional lead, as it feeds longitudinally beneath the wheel. This additional motion is obtained by mounting the pitch-block stand upon a slide and coupling it to a sliding block located in an adjustable guide. Then, as the table is fed forward longitudinally, the sliding block moves the pitch-block stand and thus by the restraint of the steel bands, rotates the shaft and helical gear. A photograph reproduced in Fig. 115 shows the operator setting the adjustable guide to the correct position to suit the helix angle. Nearly all the necessary modifications of tooth form can be obtained by adjustment of the pitch-block

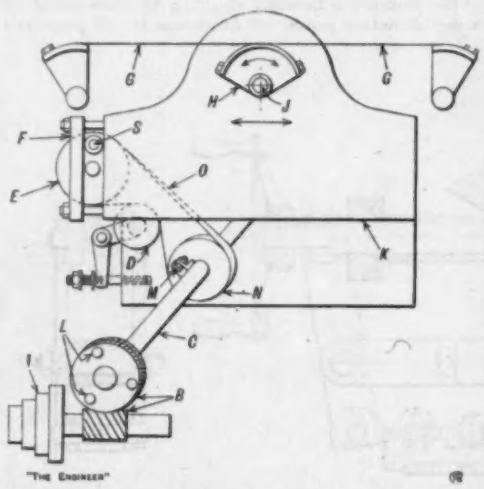



FIG. 116—OPERATION OF PITCH BLOCK MECHANISM

mechanism. Normally, the grinding wheels are set to give involute teeth of 15 deg. pressure angle, but any abnormal or corrected tooth form may be accommodated by varying the size of the pitch-block from which the involute is generated. On some machines compensating levers are connected between the reciprocating slide and the pitch-block stand, so that only nine pitch-blocks are required to cover all gears within the range of the machine. These levers can be seen in Fig. 114.

### COMPENSATION FOR WHEEL WEAR.

It is obvious that were not measures taken to prevent such an occurrence, wear of the narrow cutting edge of the saucer-shaped grinding wheels would rapidly bring about inaccuracies in the teeth ground. To obviate any such occurrence the makers have developed the neat and highly delicate automatic compensating mechanism, which is the subject of the diagram Fig. 117. It must first of all be realised that the narrow grinding edge rotates in a plane, so that if the wheels wear it is only necessary to feed them axially away from one another to correct for the wear. The means by which the two planes defined by the edges of the two grinding wheels are maintained in the correct position is indicated in the diagram. The shaft A rotates at about 10 r.p.m. and carries a cam. A roller mounted on a double lever having its centre of rotation at B is drawn into the depression in the cam surface by spring pressure every 5 or 6 seconds. The lower end of the double lever carries a flat diamond C, which, when the roller falls into the depression in the cam, approaches the edge of the grinding wheel. At the same time the upper end D of the lever approaches a stud E. Should the flat diamond touch the wheel before the upper end of the lever touches the stud, nothing happens. But should contact with the stud be made before the diamond touches the wheel an electrical contact is made which causes the grinding wheel spindle to be moved through an amount which may be varied between 0·001 mm. and 0·005 mm. The movement is effected through a pawl and ratchet mechanism. This "feeler" mechanism is in constant operation, so that in practice the plane formed by the edge of each grinding wheel is maintained exactly in position regardless of wear.

### INDEXING.

Every time the gear passes longitudinally from one side of the wheels to the other, one flank of each of two teeth is ground. Indexing may take place, therefore, either after each pass beneath the wheels or after each cycle—that is, passing beneath the wheels and back again. When indexing, the feed for the gear is automatically uncoupled. Accurate tooth spacing is secured by the use of a dividing plate with hardened and ground teeth. The plate is moved either mechanically or electrically according to the type of machine, and located by a hardened steel pin fitting into taper slots in the plate.

### THREAD GRINDING.

One of the most recent developments in the production of various parts is the application of the grinding wheel to the finishing of screw threads for taps and gauges. Thread grinding is always performed with a formed wheel, since few, if any, threads are susceptible to a generating motion. Just as in gear grinding, the gear is first formed on a cutter with a sufficient allowance for the subsequent operation, so in thread grinding the thread is usually milled, turned, or otherwise cut approximately to form. For the smaller threads, however, some makers of thread grinding equipment advise the use of a multiple profile wheel to rough out the thread from the blank. In every case the thread is finally finished with a single profile wheel. The adoption of the form grinding principle brings about the usual modifications of the machine. In general the work is fed into the wheel, the position of which remains unaltered after trimming. On a machine made by Harry F. Atkins, Ltd., of Peterborough, however, a different system is adopted whereby the wheel is fed into the work; but by means of a differential screw mechanism the position of the edge of the wheel relative to the wheel slide remains unaltered when the wheel is trimmed. The grinding wheel is usually trimmed by diamonds, the motions of which are controlled by a former plate constructed to be an accurate representation of the cross section of the finished thread on a large scale. Besides the wheel forming mechanism it is necessary on this class of machine that the lead screw shall be very accurately made. On the majority of present-day grinders it is finished to a cumulative error of well under 0·001in. per foot. Many of the machines are either equipped for or capable of taking attachments for giving relief to taps or a rapid motion over the flutes.

### A GERMAN EXAMPLE.

Some workmanlike thread grinding machines, one of which is illustrated by the engraving Fig. 118, were exhibited by Herbert Lindner G.m.b.H., of Berlin, at the last Leipzig Fair. The type of machine illustrated is suitable for grinding triangular threads of all kinds as well as single-start trapezoidal threads. It will take work between 3 mm. and 120 mm. in diameter for pitches between 3 and 40 threads per inch and in lengths up to 700 mm., and is driven either by a 3 H.P. electric motor or by belt from power shafting; it is particularly suited for tap and thread gauge grinding.

The general design is much like that of any ordinary external cylindrical grinder, and the main interest lies in the special arrangements which make it suitable for threads. Wheel dressing is performed by two diamonds, one of which produces the flanks and the other the periphery, which, when grinding, forms the bottom of the threads. For Whitworth threads some machines are provided with an attachment by which the concave part of the wheel profile—producing the top of the thread—is formed by means of a steel roller which is mounted on a shaft running in ball bearings and pressed against the slowly rotating grinding wheel. It is claimed that this method of

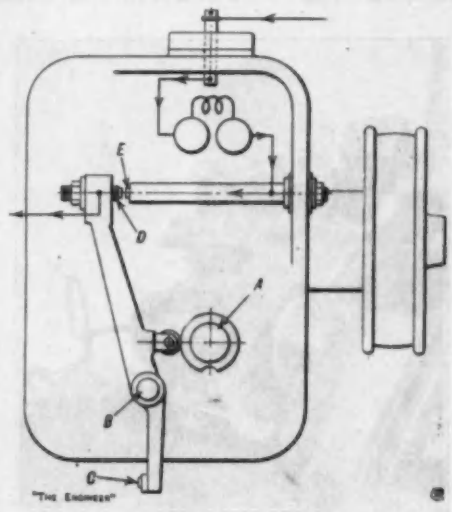



FIG. 117—COMPENSATING MECHANISM

trimming which causes the grains to break out and thereby increases the "keenness" of the wheel is more economical even than the diamond.

The correct pitch is obtained from a lead screw, the accuracy of which is claimed to be such that a cumulative error of not more than 0·005 mm. is obtained on the finished product over a length of 25 mm., and on certain machines, particularly these for gauge grinding, not exceeding 0·003 mm. On a length of 100 mm. the error does not exceed 0·0075 mm. (about 0·0003in. in 4in.). The pitch angle is obtained by swivelling the table, while a fine in-feed capable of motion by increments of 0·001 mm. is obtained by tilting the table. Sixteen different work speeds are provided by a gear-box in the work head to suit various diameters and threads. Several attachments

are available for use with the machine. One, by the use of which the flutes of taps are "jumped," much increases the productivity of the machine; while another causes taps to be relief ground. For the roughing out of threads multiple profile wheels up to 20 mm. wide may be used on the machine, but it is necessary to finish grind with a single profile wheel.

### An English Thread Grinder.

A very interesting thread grinder is illustrated by the remaining engravings. It is made by H. F. Atkins, Ltd., of Peterborough, and will accommodate work up to 3in. in diameter by 10in. long. Its capabilities in the way of rapid production are illustrated by the maker's claim that the grinding wheel can be dressed to form, and thirty-six taps, ½in. B.S. Whitworth, can be finished ground to "B" limits in one hour by a single machine. The grinding allowance is usually 0·012in. to 0·014in. and the taps are relief and taper ground. As the machine is almost automatic in operation, one operator can attend to two or more at a time.

### Grinding Spindle and Wheel Dressing Slides.

The grinding spindle runs in plain white metal bearings, and is mounted on a slide which may be swivelled in a cradle to the helix angle of the thread

FIG. 120—MOUNTING OF FORM PLATE—ATKINS

to be ground. A hand wheel graduated in minutes is provided for this purpose. Behind the wheel head and on the same slide there is a second slide carrying the wheel-dressing attachment. The two slides are actuated by a common differential screw, so that when the diamond is adjusted to true the wheel, the latter is moved towards the work a like amount. Thus the wheel may be dressed without altering the setting. To accommodate various diameters of work, the two slides are locked in position relatively to one another, and are moved forward or backward in unison by a separate screw. The amount of the movement may be observed on a dial indicator. These slides are only used for dressing and adjusting the wheel. Once adjusted, they are locked in position, and the feed is obtained by controlling the position of the cradle which, it will be observed from the tone engraving, Fig. 119, is placed at an angle instead of horizontally. Besides making it simpler for the operator to see what he is doing, this arrangement causes the cradle to have a constant tendency to slide down the slope, and thereby overcomes any troubles that might be caused by backlash.

The actual dressing of the wheel is performed by a wrought diamond fixed in a reversible holder, which is jigged on to one of the slides of the dressing attachment behind the wheel. The movements of the diamond are controlled by a stylus point following the periphery of a former, usually a reproduction at 25× magnification of the shape of the threads to be ground. This former is mounted on a plate at the top of the wheel guard, and one may be seen in position in the engraving, Fig. 120. The motion of the stylus is reduced by a suitable mechanism on to the diamond slide. Dressing the wheel, according to the makers, takes about 30 seconds, and it is stated that one dressing usually suffices for grinding about 100 taps.

### The Lead Screw.

That other very important feature of the machine, the lead screw, is made of special material to a very high degree of accuracy. Messrs. Atkins have supplied us with the report of the National Physical Laboratory upon one of these lead screws, from which it may be seen that the greatest inaccuracy over a length of more than a foot is 0·0002in. The diameter of the screw concerned was 2in., and it had four Acme threads per inch. Engaging with the lead screw when in position in the machine, there is a nut of anti-friction metal 4in. long supported by a bronze casting and mounted on hardened steel journals. Part of the outside of the nut is machined into a worm wheel, while the worm that engages with it is mounted on a rod carrying an external hand wheel. By this means the position of the work relative to the wheel may be adjusted and a dial on the hand wheel is suitably marked, so that multiple pitches may be ground. Besides a rotary motion imparted to it by the hand wheel, the worm may also be moved axially by an adjustable bar mounted at the front of the machine. By the correct use of the bar pitch corrections or other variations can be made if required. This mechanism is illustrated by the line engraving, Fig. 121, and the bar and hand wheel may be seen in the photograph reproduced in Fig. 119. Change gears, of course, interconnect the lead screw and the spindle in the usual manner.

### The Drive.

The machine is driven from a single pair of fast and loose pulleys. The pulley shaft drives at one end the oil pump and at the other carries a clutch in the traverse reverse box. This box is mounted within the body of the machine. Intermediately the pulley shaft drives a second shaft, which by the intervention of a speed cone makes three speeds available for the grinding wheel. Further speed cones on the intermediate shaft provide twelve work speeds. At the end of each traverse the table must be returned to its original position. This reversal is brought about by two Hele-Shaw friction clutches in the traverse reverse box, through one or other of which the various drives may be taken. Engagement with one or other of the clutches is brought about by the movement of a double-acting piston set in motion by oil pressure.

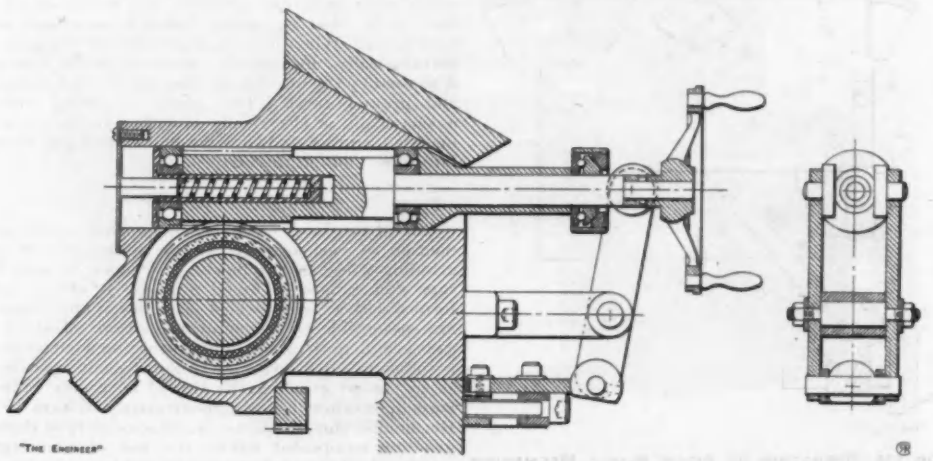



FIG. 121—ADJUSTMENT MECHANISM OF WORK SLIDE—ATKINS

The valves admitting oil to the piston chambers are automatically controlled by a lever, which is mounted on the front of the machine, and is caused by stops in a rotating disc—see Fig. 122—to move slightly up or down.

### Automatic Mechanisms.

Besides the driving shafts already mentioned, there are two others at the back of the machine. One of these is turned intermittently through a friction drive and causes a cam to rotate every time the machine reverses. In this way the grinding wheel is withdrawn from the work for the return journey of the table. This shaft also carries an excentric, the purpose of which is to pick over a ratchet wheel—see Fig. 123—once every stroke. The ratchet wheel

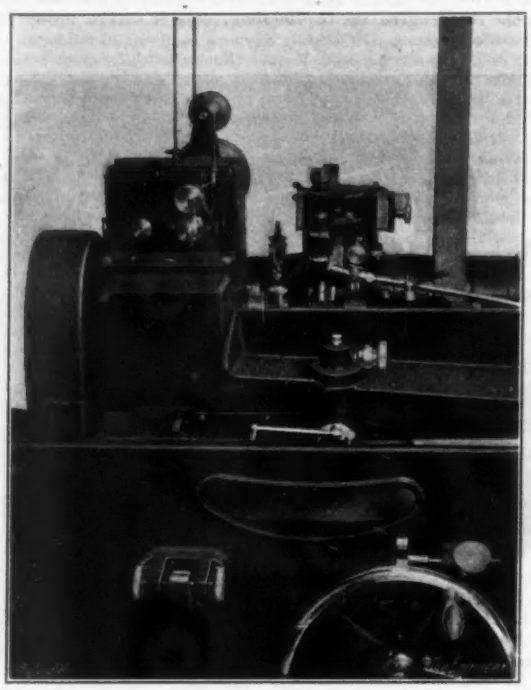


FIG. 118—LINDNER THREAD GRINDER

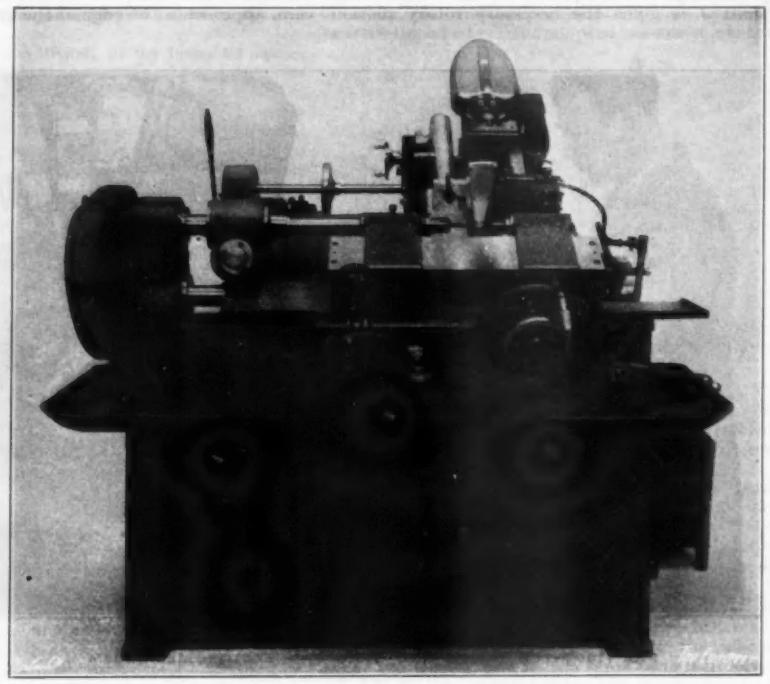


FIG. 119—ATKINS THREAD GRINDER

controls a feed cam carrying the weight of the slide, and by suitably shaping the cam, any number of cuts of any denomination, variable or constant, can be arranged for. Knock-off screws on the ratchet wheel automatically stop the feed at any desired point. The second shaft at the back of the machine can be driven at two, three, four, or more times the speed of the work spindle, according to the number of flutes on the tap, and carries a cam which gives the relief, scroll, or concentric, as required.

### OPERATION OF THE MACHINE.

The sequence of operations for grinding a tap in this machine is as follows :—The tap is inserted and a pitch finder mounted on the end of a long arm is swung over, as shown in Fig. 119. By this means the thread is

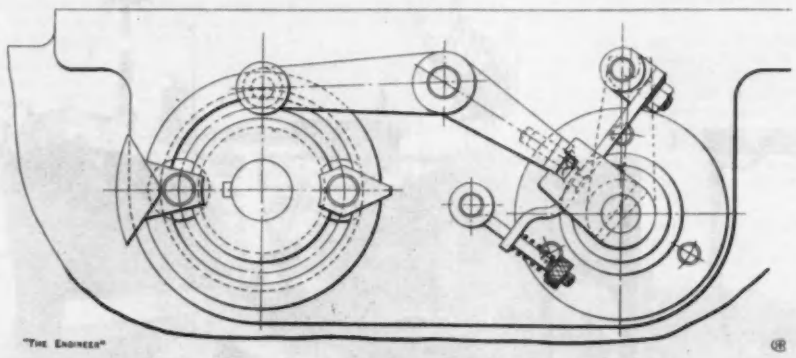


FIG. 122—TABLE REVERSE AUTOMATIC CONTROL MECHANISM

set in the correct relationship with the wheel. The machine then grinds the tap, the table returns, cut is put on, and the tap is ground again. The cycle may be repeated any predetermined number of times until the tap is ground to size when the feed is knocked off and the machine stops. For the grinding of gauges the weight of the slide is taken off the relief and automatic feed cams, and the feed is applied by hand, but the withdraw on return traverse acts as before.

### CONCLUSION.

Engineers, like the rest of mankind, have much for which to thank the development of the motor car. Though mass production methods were in use long before the motor car came into existence, their development was encouraged particularly in that trade. With the introduction of mass production

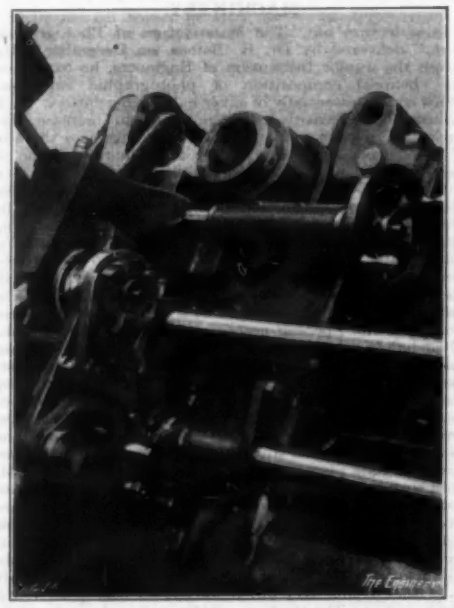


FIG. 123—WHEEL WITHDRAWAL AND FEED CAM MECHANISM

methods, the demand arose, not merely for machines capable of high production, but also for machines of high precision, for it is of little use to have a highly productive machine, the products of which are not interchangeable. It is not, therefore, surprising to find that it was, and still is, the automobile engineer who is most interested in the rapid development of grinding technique. To him belongs the encouragement that brought forth the crank shaft and cam shaft grinders. Without him it is doubtful whether the mechanism of a gear grinder would ever have been developed, and even the simple external cylindrical grinding machine owes much to his requirements. In the introduction to this series of articles we gave some figures illustrating the increasing extent to which grinding machines are being employed. Their uses are also expanding into new fields. Thread grinding has been developed within recent years, and gear grinding is by no means old. The grinding of splines is bringing spline shafts into favour in applications hitherto held exclusively by the key. Perhaps in the not far distant future the grinding machine will be performing many of the functions at present carried out by other machines, but it is more probable that it will cause no displacement of such machines, but will be utilised for finishing the parts they produce.

Part of the reason why the grinder has not developed even faster is the difficulty ofproducing large wheels of which the user may be sure the grade is the same throughout. There are advantages in speed of production to be gained if the wheel is as wide as the length of the work, but at present there is a more or less definite limit to the width of the wheel. This trouble will no doubt be overcome in the future, if not with the ordinary vitrified wheel in use at the present day, then perhaps by the use of bakelite-bonded wheels or some other bonding material not yet tried. That grinding still has a great future before it should be demonstrated by this series of articles, now concluded.

## American Engineering News.

### Garbage Incineration at Baltimore.

AFTER disposing of its garbage by hog feeding, burial, reduction, and sale as fertiliser for several years, the City of Baltimore has now adopted disposal by incineration or destruction. Dry rubbish is already destroyed in incinerators, but these will have to be rebuilt to adapt them for the destruction of garbage. But besides these a new destructor is to be built, having a capacity for handling 600 tons daily of both garbage and rubbish, regardless of moisture content and weather conditions. In the combustion chamber the temperature is to average 1450 deg. Fah., with a minimum of 1200 deg.; all material, with the exception of combustibles, must be reduced to a mineral ash containing not more than 1 per cent. of carbonaceous matter. There must be no nuisance from smoke, odours, gases, sparks, or dust. For each 65 lb. of garbage delivered at the new destructor the contractor must deliver at least 35 lb. of dry rubbish, the remainder of the rubbish going to the present destructors. The new destructor will have top-feed furnaces, each unit equipped for supplying fuel oil and injecting it into the furnace to help combustion when the moisture content of the mixed material is too high for normal burning. The furnaces will operate under forced draught, with preheated air. Each combustion chamber will have a volume of 15 cubic feet per square foot of effective grate area, with a rating of not more than 70 lb. of mixed garbage and rubbish per hour per square foot. The drying hearth will have an area equal to at least 50 per cent. of the effective grate area. In 1931 the collection amounted to 80,000 tons of garbage and 130,000 tons of rubbish. Garbage is collected by the city and rubbish by the contractor. Payment for disposal will be based on the quantities, and at the end of ten years the new destructor is to become the property of the city.

### U.S. Government Aids Public Works.

Under the Relief Act, passed to assist in overcoming the business depression and consequent unemployment and distress, the American Reconstruction Finance Commission has made loans totalling £14,000,000 for public works, which will earn sufficient income to repay the loan. In order not to interfere with banks which may be willing to make loans on such projects, the Commission requires rather high interest charges, with 5 per cent. as a minimum. Among these loans already made are about £8,000,000 towards the 240-mile Los Angeles aqueduct, and £1,000,000 for the 42-mile railway which will connect the Moffat Tunnel line with the Denver and Rio Grande R.U., and thus reduce the rail distance from Denver to the Pacific Coast by about 150 miles. Innumerable applications for loans are being made, but the law requires that they must be revenue-earning projects that assure ability to repay the loan and interest. The New Orleans bridge, is another "loan" project. It will have a clear span of 3525ft., and very long approaches as the ground is low and flat, while the river span will have a headway of 135ft. Further, owing to the soft formation, the foundations must be carried 175ft. to 200ft. below low water. It will carry both railway lines and highways, and is estimated to be built in about two years. Many of the loans requested are for municipal waterworks sewage treatment works, electric light plants, and swimming pools, the amounts in some cases being as low as £10,000. Among the larger projects are £10,000,000 for underground railway extensions at New York; £2,500,000 for a bridge across Chesapeake Bay, and £10,000,000 for continuing the great sewage treatment works at Chicago, now halted by lack of funds.

### Irrigation and Hydro-electric Plant.

An unusual feature of the new Eagle Pass hydro-electric station is that it takes its water supply from an irrigation canal heading in the Rio Grande River, in Texas. The flow capacity of the canal is 1500 cubic feet per second, with a guaranteed minimum supply of 1200 cubic feet per second to the power station. About 15,000 acres are under irrigation. The head race is a branch canal 1250ft. long, ending in the forebay, while the tail-race is a channel 1500ft. long, discharging into the Rio Grande. The working head is about 82ft. Three riveted steel penstocks 11ft. in diameter lead from the forebay to the turbine-room and are buried underground in order to reduce temperature variations. There are three vertical shaft turbines with runners 4ft. 8½in. in diameter, developing nearly 5000 H.P. at a speed of 225 revolutions. A power lubricating system, with grease-gun operating at a maximum pressure of 1000 lb. per square inch, provides lubrication at about eighty points on the gate systems, links and shifting ring at one "shot." The generators—of Westinghouse make—have each a capacity of 4000 kVA at 0·8 power factor, generating current at 60 cycles and 6900 volts. They are supported on steel girders sealed in the walls, this unusual arrangement being more economical than the usual concrete barrel built upon the turbine speed rings, owing to the great height between the turbine and generator floors. Since the canal provides no pondage or storage, a by-pass with automatic Tainter gate is provided to carry water to the river in case of shutting down any of the turbines. This by-pass is a steep concrete channel, ending in a stilling pool, with overflow to the river. Three generating units are provided in order that one can be shut down for examination or repair during periods of reduced flow.

### Air Conditioning for Buildings.

A new and growing development in American building design and equipment is the introduction of air-conditioning apparatus for the washing, filtering, and cooling—or warming—of air which is then distributed through the building under high pressure. Equipment of this kind has been applied to railway passenger cars, especially dining and sleeping cars, and to theatres, but the system is now being adapted to office buildings, residences, bakeries, confectionery, and drug manufactories, textile mills, and other industries. In some buildings designed for this system the windows are fixed and cannot be opened. In fact, at least one factory building has no windows, relying entirely upon electric light and air-conditioned heating and ventilation. This, however, is rather an extreme case at present. In new buildings the necessary conduits and ducts are carried up with the structural steel framing, and are so arranged as to be largely concealed or inconspicuous. For existing buildings considerable ingenuity may be required to introduce a satisfactory arrangement of ducts with regard to appearance and minimum loss of space. Air conditioning units are made in capacities ranging from 800 to 12,000 cubic feet per minute of conditioned air. The small units are suitable for houses of eight or ten rooms. The 33-storey Philadelphia Savings Fund Building has air-conditioning machinery supplying 350,000 cubic feet of air per minute, operated in connection with four large refrigerating machines. To prevent the system from being thrown out of balance if some tenants insist on opening the windows, the air is delivered at high pressure through nozzles, which are so arranged as to prevent noise and draughts.

### Commercial Research in America.

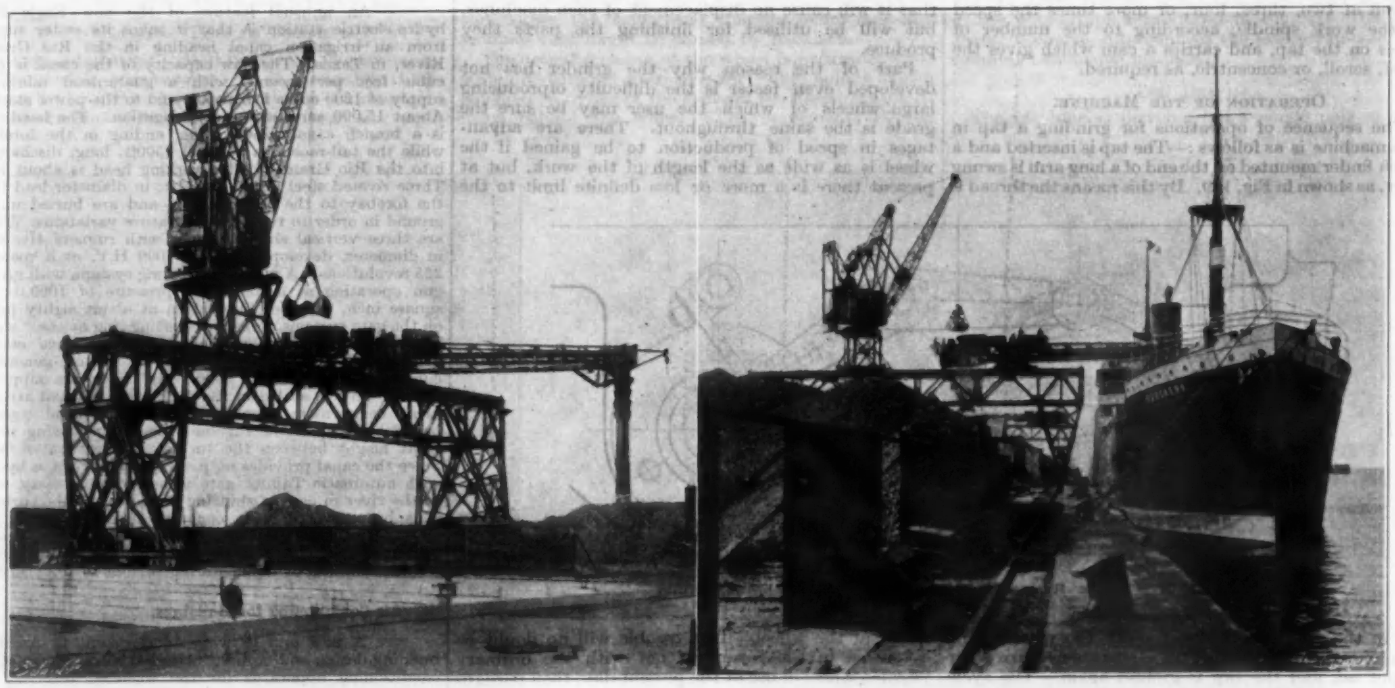
THE practical and great financial advantages of systematic research by large American manufacturing concerns was explained recently by the engineer in charge of the so-called development department of an electrical company. From a few engineers beginning in a rather vague way, but having a broad vision and looking upon the shop practice and equipment from a different standpoint than that of the shop foreman, this department has become a large and highly important organisation. This result is due, of course, to the direct and practical value of its work. Its two main lines of activity are in cost reduction and mechanical improvement, while cost reduction studies often lead to quality improvement. Some years ago, a rather indefinite study was made of the possibility of improving the methods of manufacture of the electrostatic condensers used in telephone work, but it was concluded that certain changes proposed would not be profitable, and the study was abandoned. When taken up anew and on a more definite basis by the development department, the results were a great reduction in size of the condenser, higher efficiency and uniformity, motor operation of machinery, a great increase in daily output, and a reduction of cost. Even allowing for the cost of development studies and the cost of designing and building special machinery, the net production cost per condenser was cut in half in a period of five years. Results are not always so striking, for the study required to mechanise a small-scale production operation may be as great as that for mechanising an operation that involves large-scale production. Taking the development department as a whole, however, it has returned annually about four times the amount spent upon it.

### Electrical Operation of Steel Mills.

The generating capacity of the power stations at the South Works of the Illinois Steel Company, is 265,000 kW, and power requirements with the recent expansion of the works are estimated to reach 450 million kilowatt-hours per year, with hourly peaks of 85,000 kilowatts. Besides the large rolling-mill units, current is required for lighting and heating, and for numerous small applications of power in cranes, shops and foundries. The first application of electric power was for overhead travelling cranes, about 1892, and later for an electric-hydraulic charging crane at the reheating furnaces.

# COAL HANDLING PLANT AT GIBRALTAR

CLARKE, CHAPMAN AND CO., LTD., GATESHEAD-ON-TYNE, ENGINEERS



But the advantages of electric drive were so apparent that motors began to be applied extensively to cranes and charging-cars. The use of A.C. began in 1903. On account of the fluctuating demand on D.C. converting and generating equipment, large 250-volt storage batteries were installed to reduce the peak loads. Electrically driven main-roll equipments were first installed in 1907, two groups of rolls in the light-rail mill being each operated by a pair of induction motors. About 1916, the 30in. plate mill was equipped with reversing electrical plant, consisting of two 600-volt motors of 2000 H.P. This mill is still in operation and has had no electrical troubles. A 15-ton Heroult electric furnace was installed in 1909. At present the main-roll drives total 115,817 H.P., or 86,500 kilowatts. The two-high blooming mill for H. section rolled joists, rolled from 20-ton ingots, has a 5000 H.P. motor for each roll. The roughing mill has a 7000 H.P. motor for the web rolls, and a 2000 H.P. motor for the flange rolls. The intermediate mill has motors of 6000 and 2000 H.P., and the finishing mill has a 3000 H.P. synchronous motor. Numerous motors are required in addition to operate the tables, shears, saws and other steel mill machinery.

## THE TREVITHICK CENTENARY.

As we have already reminded our readers, the centenary of the death of Richard Trevithick occurs on April 22nd next. Trevithick deserves to hold a place in the memory of engineers beside those of Newcomen, Watt, and Stephenson, for he was the protagonist of high-pressure steam and the builder of the first railway locomotive.

A committee has been set up under the chairmanship of the President of the Institution of Civil Engineers to make arrangements for the celebration of the Trevithick Centenary, and has already made good progress with a programme. It is proposed that memorials should be unveiled at his birthplace, Illogan, in Cornwall; at Pen-y-daren, where his first railway locomotive ran; and on some appropriate site near Euston, where his circular railway of 1808 was built. An exhibition illustrating his life and work is to be arranged in the Science Museum, South Kensington, and an eminent engineer has promised to deliver a Memorial Lecture. Furthermore, it is proposed that a new "Life of Trevithick," which is being written by Mr. H. W. Dickinson and Mr. Arthur Titley, should be published as a memorial volume. For some or all of these things money will be needed, and an appeal is being circulated by the Committee, which has its headquarters at the Institution of Civil Engineers, Great George-street, Westminster. The Committee recognises that large contributions cannot be expected at the present time, but it hopes to receive small sums from engineers all over the world who desire to pay a tribute to the memory of a very famous man. Messrs. Coutts and Co., 440, Strand, W.C.2, are acting as treasurers, and cheques or postal orders may be sent direct to them. The fund has the support and sympathy of all the principal engineering institutions of the country.

It is also proposed that memorial services shall be held in Westminster Abbey and in Dartford Church, in whose cemetery Trevithick was buried.

IN the *London and North-Eastern Railway Magazine* for December are some interesting statistics as to the painting of the Forth Bridge. The area of the steel work covers 145 acres, and twenty-four men are wholly engaged on the work. One complete painting is given to every part of the bridge in each three years, and 50 tons of paint are required.

## New Coal Handling Plant at Gibraltar.

IN addition to its strategic position as the key to the Mediterranean and the East, Gibraltar is of considerable importance as a bunkering station, and in that connection it is interesting to notice that the erection of modern coal-handling plant on the mole has just been completed. This plant, illustrated herewith, comprises four sets of cranes, loaders and transporter bridges, all electrically driven from current supplied by a generating plant situated on the mole. All of the plant has been made to the order and requirements of Gibraltar Transporters, Ltd. The cranes, constructed by Clarke, Chapman and Co., Ltd., Gateshead-on-Tyne, are of the level luffing, high-speed type, and have been specially designed for quick, efficient and economical working in order that colliers may be quickly discharged and ships bunkered. Special care has been taken to ensure that the cranes may work for long periods with little attention. No luffing ropes are required with this type of level luffing crane, and in the case of the hoisting motion extra large barrels and pulleys are fitted to reduce the rope wear to a minimum. All the pulleys are fitted with special oiling arrangements to enable them to run for long periods without attention. Limit switches are fitted at each end of the luffing motion.

The grab, which is of the double-rope type and capable of handling 2½ tons of coal, is partially balanced by weights, which slide up and down in guides fitted at the tail end of the crane. These weights, which also act as ballast for the crane, are connected by means of a rope to an extension of the hoisting barrel. Limit switches are fitted to prevent overwinding in either direction.

The holding barrel, which is on the same shaft as the hoisting barrel, is fitted with a very powerful clutch capable of raising the open grab if desired. Special attention has been paid to ensuring that the grabbing operations will be performed efficiently. The danger of the ropes coming out of the grooves in the barrels and pulleys as a result of the ropes becoming slack has been reduced to a minimum. Gear fitted inside the jib and connected by means of a bridle chain to the grab prevents the grab from twisting, and pulleys attached to the grab for coupling it up to the bridle enable the grab to work efficiently at any height and in any position.

The portal of the crane is arranged to allow the loader to travel through from one end of the bridge to the other. Powerful clips, operated from platforms on either side of the crane, are fitted to engage with the crane rails to supplement the work of a magnetic brake which holds the crane in any position on the bridge. These clips are sufficiently strong to prevent movement of the crane by wind pressure, which, in such an exposed position, is often considerable. In addition to rail stops, of steel plate construction, placed at each end of the bridge, limit switches are fitted to prevent the crane being over-run on the bridge. The bridges, also constructed by Clarke, Chapman and Co., Ltd., are 102ft. span from centre to centre of the quay rails, and are arranged to clear coal stacks 25ft. high. They are mounted on four two-wheeled compensating bogies, one fitted to each corner. Two motors synchronised for exact speed are fixed near the base of each leg and can move the bridge at 50ft. per minute. Special attention has been given to preventing coal dust from coming in contact with the lubrication, and scrapers are fitted at the end of each bogie to clear the rails when the bridge is travelling. A rail clamp is fitted at each end of the bridge to prevent its movement under wind pressure.

On each bridge and running on separate lines inside the crane rails there is mounted a machine designed for bunkering ships with the least amount of trimming labour. The coal is deposited by the grab into a hopper which automatically weighs each load and adds up the tonnage on a counter. After weighing the coal is gently shot on to a conveyor belt extending over the ship to be coaled, and is discharged through a flexible tube right into the bunker hatch of the ship, thus avoiding the necessity of the grab being swung over the steamer and the consequent risk of damage to the vessel.

The whole installation is capable of dealing with 700 tons of coal per hour. The Gibraltar mole can store about 50,000 tons of coal of various qualities ready for immediate use. The coaling site is sheltered from the weather and is capable of taking vessels of any size and draught.

## MAKING PHOTOGRAPHIC FILMS BY MACHINERY.

IN a lecture on "The Manufacture of Photographic Film," delivered by Dr. H. Baines, on December 15th, before the Junior Institution of Engineers, he explained the chemical composition of photographic emulsions which consist essentially of silver halides in gelatine. Such emulsions are sensitive to light, but to increase this sensitivity require to be ripened; this increases the size of the suspended grains; thereafter more gelatine is usually added and the emulsion chilled, which sets it as a stiff gel. In order to wash out the alkali nitrate and excess alkali halide the gel is shredded by forcing it, by hydraulic pressure, through a silver plate, the resulting shreds being placed in a canvas bag which is suspended in running water until all the soluble constituents are completely removed. The washed shreds are then drained, melted, made up to a standard bulk by the addition of water and gelatine, and then "digested" by a second heat treatment similar to the ripening process. During this process the silver halide grains do not usually alter much in size, but their photographic sensitivity and contrast in many cases increase very markedly. Great care is essential to stop the digestion process in time and to control the heat, or the emulsion becomes foggy; anti-bacterial preservatives are added and the emulsion is again set by chilling, and kept in a refrigerated store. In coating celluloid or paper strips or glass plates the emulsion is melted at a suitable temperature and certain chemicals are added to facilitate coating and to improve the physical properties of the emulsion, which, in liquid form, is fed to the coating machine. Celluloid and paper bases are in strips 42in. wide and upwards of 1000ft. in length and receive the coating of emulsion in passing round a roller in contact with it. Other drums over which the coated base passes chill the emulsion. The thickness of the coating depends on the viscosity of the emulsion, and this is controlled by the addition of chemicals so that the speed of the coating machine may be kept constant. The coated film then passes to a drying machine, which suspends it in loops whilst it passes down a drying track, at the end of which it is re-rolled and placed in store pending cutting and final operations. Glass plates are coated by placing them horizontally with edges touching on a travelling band conveyor which passes under an overhead feeding trough in which the emulsion is stored and from a slit in the bottom of which it issues in ribbon form the width of the plates; after coating, the plates pass on to another band, the lower loop of which is immersed in water and the whole thus kept wet and cold so as to set the emulsion. In passing off this conveyor on to another set at a downward angle the plates, with their continuous coating of emulsion, in passing from one to the other, are separated by the breaking of the film at the edge of each plate. The necessity for excluding all dust from the coating room and machines involves elaborate air cleansing and conditioning plant; likewise the purity of all the chemicals used and the utmost cleanliness in all the operations. An impurity of 0·000001 per cent. of most metals and their salts, and of many organic materials, when concentrated in specks, ruins a photographic product.

## Railway and Road Matters.

THE western extension of the London Electric Railways from Hammersmith, which was opened as far as Acton Town on July 4th last, will be brought into use throughout to Northfields on January 9th.

THE last public hearing of the National Wages Board was held on Tuesday, December 20th. Sir Harold Morris in closing the proceedings, said that the Board would do their best not to delay their findings, but they probably would not be available until about the middle of January.

THE new electric train service between London and Brighton and Hove will be brought into use on Sunday next, January 1st. That will see the completion of a scheme announced in October, 1929, as a consequence of the remission of the passenger duty. The work must have been carried out much more expeditiously than was intended, as the annual report, issued in February last, spoke of its completion "early next year."

THE disadvantages under which the residents in the Ilford district labour in the matter of railway transport do not seem likely to be removed just yet. At a public meeting on December 12th to protest against the existing conditions, a letter from the L. and N.E.R. was read, which said that electrification would not give the relief desired, as it would not increase the line capacity, whilst a tube from Liverpool-street to Romford would cost twelve millions, and would only give a meagre return on the capital expenditure.

THE Ministry of Transport railway statistics for September show that, when compared with the corresponding month of 1931 the number of passenger journeys decreased by 3·8 per cent. and the receipts from passengers by 4·7 per cent. The freight returns are for the four weeks ended October 8th, and when compared with the corresponding period of 1931, show a decrease of 9·6 per cent. in the freight tonnage and of 14·0 per cent. in the receipts. The average train load decreased from 124¾ tons to 117¾ tons and the net ton-miles per engine hour from 462¾ to 439¾.

IN co-operation with the West Riding educational authorities, the London and North-Eastern Railway Company gave demonstrations in railway working at Leeds to over 4600 school children from various centres on four days a week during a recent four-week period. Each demonstration covered an inspection of the train control office, and a lecture on railway operation in a waiting-room specially set aside for the purpose. Special features were an inspection of a full-size signal, points, and lever frame, and a signalling lecture given in two specially equipped vestibuled vans.

A NOVEL suggestion was made by Mr. E. L. Leeming, surveyor to the Barton-upon-Irwell Rural District Council, in a paper read before the members of the Institute of Transport in Manchester a few days ago. Mr. Leeming suggested that the railway companies should equip their large bridges with wooden decking, so that they could also be used by ordinary road vehicles. The bridges he had in mind are the Forth Bridge, Menai Bridge, Charing Cross, and those at Barmouth, and across the Severn at Lydney. All these, he said, could by some means be adapted to carry road traffic, and thus yield substantial tolls to the owners.

ON page 389 of THE ENGINEER of October 14th last it was noted with satisfaction that the railway companies were able to retain their hold on the parcels traffic. The Railway Returns for 1931 show that that traffic was of a gross value of £13,387,758, which figure, compared with £14,318,688 in 1928, showed a reduction of only 6·5 per cent., which is less than would be expected from the falling off in trade. Among the amounts that made up the total for 1931 we notice £6,747,978 for parcels of less than 2 cwt., £2,140,571 from newspapers, milk brought in £1,245,056, meat £110,194, fish £1,470,640, fruit and vegetables £240,611, butter, cream, eggs, and margarine £54,907.

COLOUR LIGHT signals, which light up automatically on the approach of a train and are extinguished as soon as it has passed, are being installed by the L.M.S. Railway between Bay Horse and Garstang, two stations in Lancashire 5¼ miles apart on the main line to Carlisle and Scotland. The installation will enable an existing signal-box at Scorton to be dispensed with, the new signals being controlled electrically from Bay Horse and Garstang signal-boxes. One signal will be controlled by a signalman no less than 3 miles 645 yards away, but perfect safety is assured, as, in the event of failure of the signal lights, detonators are automatically placed on the rails as a warning to engine-drivers to stop.

A DEVELOPMENT of recent years on British railways is what is known as a sand drag. The use of it, which will explain its general purpose, may be judged from the fact that whilst sidings and the outlets from goods lines are provided with safety points in order to derail anything that would irregularly enter upon a passenger line, such are not used under similar circumstances where passenger trains are concerned. A sand drag consists of laying each rail of the safety points in a trough of sand, which effectively stops the movement without the fear of the train or vehicle running into the buffer stops at the end of the safety point. A yet more recent development is the provision of a sand drag on heavily falling gradients in order to intercept trains that have got out of control and are running away. These sand drags have two lines parallel and interlaced with the running lines, and are entered by facing points which are opened by the man in the nearby signal-box when whistled for by the driver of a train out of control. The engine and train then plough their way through the sand drag and are pulled up before they reach the trailing points where the parallel rails join the main rails again. Sand drags are also used at the end of runaway catch points, so as to reduce the damage to vehicles that may run back. The first in this country of the last class was fixed by the London and North-Western Railway in Waterloo Tunnel, Liverpool, in 1900, and the first of the type to intercept trains out of control was laid down by the Lancashire and Yorkshire on Baxenden Bank in 1907.

## Notes and Memoranda.

WE cut out from the editorial columns of the *Engineering News-Record* of America a few words that seem *apropos* many occasions:—"Such a state of affairs, sometimes found also in other engineering fields, suggests that habit has more influence on engineering method than is altogether reasonable."

THE carborundum filters fitted to some $CO_2$ recorders will inevitably clog after some use, and they should be cleaned by some means. A valve, arranged so that the filter can be disconnected from the instrument, and a connection made so that compressed air can be passed through the filter in the reverse direction to that of the gases, will, says the *Electrical Review*, serve the purpose. The air should be at a pressure of between 10 lb. and 15 lb. per square inch, and this will quickly remove any dirt which has collected.

AN interesting sidelight on electrical railway traction is shown in the report of the South Indian Railway Company, which states: "The results of the Madras Suburban electrification, for which two additional lines of track have been laid, are distinctly encouraging. The number of passengers in this area now averages 125,000 per week, whereas under steam traction with single-line working the maximum recorded for one week was only 33,000, and the operating costs show a saving over those of the steam working."

BUILDING accidents are, says the *Engineering News-Record* of New York, a very large item in the cost of building operations. The number of fatalities is increasing, and the less serious injuries are likewise growing in number. The economic results are very serious. On the basis of 7,000,000,000 dollars of new construction a year, allowing 40 per cent. as the cost of labour and applying the average compensation insurance cost per 100 dollars of pay roll and the average paid-claim ratio, it is estimated that the direct losses for which employees are compensated amount to more than 54,000,000 dollars.

AN improved and inexpensive process for the purification of crude carbazole is described by Dr. E. Kenngott, of Waldshut, in the *Chemiker Zeitung* of December 7th, 1932. The crude material, usually 25–30 per cent., as dry as possible, is dissolved in three times its weight of creosote oil. The solution is effected in a vessel provided either with a steam jacket or with steam coils. The carbazole is added slowly at a temperature of about 96 deg. Cent. As soon as the whole is added, the temperature is raised slowly to about 125 deg. to 135 deg. Cent., and maintained for several hours, the vessel being provided with an efficient agitator. A short reflux condenser serves to condense the small quantities of low-boiling tar oils and water which gradually evaporate.

IN the third of the series of lectures on industrial affairs, at the Imperial College of Science, Mr. Maurice Solomon discussed certain aspects of the electrical industry. He emphasised that further developments of the industry would involve a more widespread use of electrical appliances in the household. Such appliances must be properly standardised so as to be readily interchangeable. Moreover, there must be standardisation of quality, for it is of the utmost importance that the user shall acquire and retain confidence in the safety and smooth working of electrical apparatus. As an indication of the extent to which electricity may be applied in the modern household, Mr. Solomon said that in his own house there are some twenty-eight different types of electrical appliance in use.

THE Hetch Hetchy water supply project for San Francisco, Calif., when completed, will supply 400,000,000 gallons of water daily for a future metropolitan population of 5,000,000 and will develop 250,000 hydro-electric horse-power. Water will flow by gravity through an aqueduct to San Francisco, without pumping and without exposure to contamination. The work is now complete, with the exception of the Coast Range tunnel. This tunnel, the longest in the world, is 25·2 miles long, and about 1000 workmen are now employed in constructing it. Over 21 miles has already been driven. Five shafts, two of them over 800ft. deep, were sunk to facilitate the work, and tunnelling is carried on from twelve working faces. The tunnel is circular, 10½ft. in diameter, and is concrete lined its entire length.

AMONG the inquiries which have been submitted to the Building Research Station there is one which concerned the glazed tiling applied on the face of a concrete wall, which tiling bulged objectionably. The Research Station suggests that the fundamental cause of most of such failures is that all cement concretes and mortars shrink as they dry out, whereas a well-fired clay product such as a glazed tile has a negligible shrinkage in comparison. In addition to this shrinkage, concrete structures are liable to undergo a certain amount of deformation, usually known as "creep" or flow under load. It will be seen, therefore, that in applying a dense inert skin of tiling to a concrete background, which is far from inert in its early life, a considerable stress is likely to be set up in the tiling by differential movements, and, in the event of any weakness in the adhesion of the tiles to their bed, it is quite likely that they may be displaced.

IN order to protect the 220-kV windings of the power transformers at the Toronto-Leaside station of the Hydro-Electric Power Commission of Ontario, lightning arresters of the auto-valve type have been installed, says the *Electrical Review*. Those put into operation in 1930 are of the disc type, while the two three-phase sets recently installed are of the modern porous block type. The arresters are rated at 268 kV, and not, as usual, at the phase-to-earth voltage; each phase leg is equipped with an automatic switch operated by a potential relay which inserts the short-circuited portion of the stack into the discharge path of the arrester when the system voltage rises above a predetermined value. In this way the arresters are protected if a flash-over should occur on their gaps at such a time. The switches are closed only during the lightning season or when there is a lightning storm in the vicinity. The opening of a switch is indicated in the control room.

## Miscellanea.

EGYPT and India will be linked by wireless telephone in March next year.

THE proposals for Galway Harbour, in Ireland, will involve the expenditure of some £400,000.

A TUNNEL under the Scheldt for vehicular traffic and another a mile away for pedestrians have been opened at Antwerp.

THE 1,000,000-bushel extension to the United Grain Growers' elevator on Burrard Inlet, Vancouver, has been completed.

BRITISH equipment has been ordered jointly for five new cotton mills to be constructed at Ahmedabad. This was previously the centre for Indian Congress boycott of British goods.

A POWER plant of 220,000 horse-power is to be constructed on the White River, at Table Rock, in Missouri. It will involve the expenditure of 30,000,000 dollars, and produce a lake 65 miles long.

PLANS for giving aeronautical engineering pupils a period of practical experience in commercial life as the final part of their training have now been approved by the Advisory Council of the College of Aeronautical Engineering.

IT is recorded that while Imperial Rome used some 50 gallons of water per capita per day, the consumption of Mediæval Paris amounted to about 1 quart. The present consumption in Tacoma, U.S.A., is 430 gallons per head per day.

ACCORDING to Canadian Government geologists, the pitchblende ores from the Great Bear district are extremely rich, averaging between 40 and 50 per cent. of uranium oxide, capable of producing about 125 milligrammes of refined radium to the ton.

A MARKED increase in the use of coke in Canada during the past few years has resulted in the erection of several new coking plants. With this new construction the producing capacity of Canadian plants is now sufficient to meet the ordinary demands of the country for coke fuels.

EXCEPT for the installation of automatic and lift gates in the waste weir, which is now being carried out according to programme, and a few works of a minor character, the construction of the Krishnaraja Sagara Dam, in Mysore, may be said to be completed. It is the largest engineering work undertaken in the State.

A LONDON committee of the Scottish National Development Council has been formed to further the work of restoring prosperity to Scotland. The Council itself was formed as a non-political body rather more than a year ago, its aim being to assist in the promotion and development of industry, agriculture, fisheries, mining, and transport.

WHAT is described by the Canadian Minister of Mines, Ontario, as the most important oil well drilled in recent years in Ontario has been opened near the village of Doyle, in the western part of the Province. The possibilities of the new district, which is distinct from the Petrolea oilfields, have not yet been determined, but are promising.

DOG-TEAM transport will, according to a paragraph in *Canada*, soon be a thing of the past in northern Manitoba. Aeroplanes and railways are driving it out of existence. As an illustration of the trend of the times, a beautiful team of "huskies," with harness and Alaska sleigh, which three years ago would have been worth at least £60, was sold a few days ago for £15.

AN order has been placed by Bowater's Mersey Paper Mills, Ltd., of Ellesmere Port, with Charles Walmsley and Co., of Bury, for two newsprint paper-making machines. The contract is for nearly £250,000. The factory will have a capacity of 60,000 tons of paper a year and will cost, including the buildings, which are to be put up by Redpath, Brown and Co., some £850,000.

THE United States Bureau of Reclamation will receive bids at its Denver office until February 3rd, 1933, for furnishing three, four or five 115,000 H.P., vertical shaft, hydraulic turbines, with or without butterfly type shut-off valves, and one or two 55,000 H.P. vertical shaft turbines with governors for installation in the Hoover Dam power plant. The 115,000 H.P. turbines will be the largest capacity turbines yet built. Those built recently for Dnieprostroy, in Russia, have a capacity of 84,000 H.P.

THE crushing of linseed and rape seed obtained from the plants of northern Europe has, says *Nature*, long been a staple industry at Hull, which now claims to be the largest oil mill centre in the world. In view of this, it is interesting to learn that the Museum contains a remarkable series of models of seed-crushing plant illustrating both old and new methods. The models were described in the *Model Engineer and Practical Electrician* in April last, and the articles have now been published in pamphlet form as Hull Museum Publication No. 176. The models have been made by Mr. W. Marshall, who began his connection with the industry as a blacksmith in 1869, rose to be manager of some of the largest mills, and became a manufacturer of oil mill plant.

A SPECIALLY designed motor boat, which is to be used on Lake Titicaca, Bolivia, about 12,000ft. above sea level, has recently been delivered to the Bolivian Government by the Swedish Penta Works. The boat, which is to be used by the Customs Department of Bolivia, is built of mahogany, fitted with a six-cylinder Penta engine, and reached a speed of 22 knots with two men on board at the recent trial run. The air pressure on Lake Titicaca, however, is only 480 mm., as compared with a normal pressure at sea level of 760 mm., whereby the power of the engine is reduced by no less than 40 per cent. The engine, therefore, had to be specially tuned for these unusual conditions, and the carburetter was enclosed in an air-tight box with an adjustable air supply and a vacuum gauge. The engine was then run at a vacuum corresponding to an elevation above sea level of 13,000ft., and attained a speed of 16·75 knots, which is considerably in excess of the stipulated one.

# 1,500,000-kVA SWITCHGEAR TESTING PLANT

A. REYROLLE AND CO., LTD., HEBBURN-ON-TYNE

(*For description see page 672*).

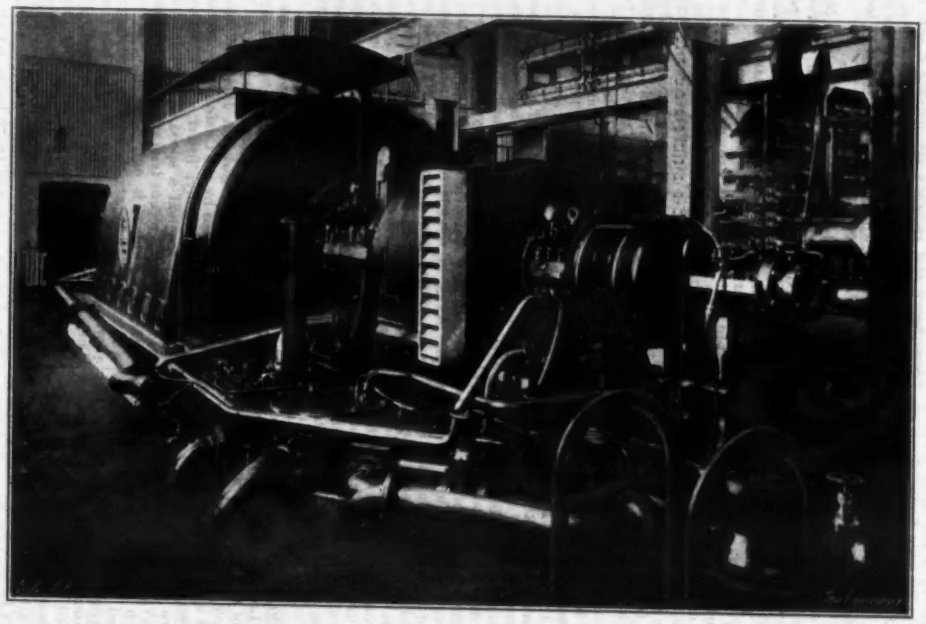


FIG. 1—1,500,000-kVA ALTERNATOR IN TEST-HOUSE

FIG. 2—RESISTANCES AND REACTORS

FIG. 3—NEUTRAL POINT SHORT-CIRCUITING SWITCH

FIG. 4—OSCILLOGRAPH ROOM IN CONTROL HOUSE

# The Engineer

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VOL. CLIV. No. 4016


## Contents.


THE ENGINEER, December 30th, 1932. PAGE

A SEVEN-DAY JOURNAL .. 657
A RE-HEATING TURBINE INSTALLATION IN JAPAN. (Illus.) .. 658
STATISTICS AND ENGINEERING. No. IV. (Illus.) .. 661
PRECISION GRINDING MACHINES. No. XV. (Illus.) .. 662
AMERICAN ENGINEERING NEWS .. 665
THE TREVITHICK CENTENARY .. 666
NEW COAL HANDLING PLANT AT GIBRALTAR. (Illus.) .. 666
MAKING PHOTOGRAPHIC FILMS BY MACHINERY .. 666
RAILWAY AND ROAD MATTERS .. 667
NOTES AND MEMORANDA .. 667
MISCELLANEA .. 667
LEADING ARTICLES—
Boilers and Heat Pumps .. 669
Yesterday and To-day .. 669
OBITUARY—
Archibald Gilchrist .. 670
LITERATURE .. 671
BOOKS RECEIVED .. 671
COL. BATTYE MEMORIAL FUND .. 671
1,500,000 KVA ALTERNATOR AND SWITCHGEAR TESTING PLANT. (Illus.) .. 672
AN OIL-ELECTRIC FERRY-BOAT WITH HORIZONTAL ENGINES. (Ill.) 673
NICROSILAL HEAT-RESISTING CASTINGS. (Illus.) .. 673
AN OMNIBUS TESTING MACHINE. (Illus.) .. 673
THE "ANDERSON" ROTARY STEAM ENGINE. (Illus.) .. 674
PROVINCIAL LETTERS—
The Midlands and Staffordshire .. 674
Lancashire .. 675
Sheffield .. 675
North of England .. 676
Scotland .. 677
Wales and Adjoining Counties .. 677
BRITISH STANDARDS INSTITUTION .. 677
PERSONAL AND BUSINESS ANNOUNCEMENTS .. 677
LAUNCHES AND TRIAL TRIPS .. 677
CALENDARS, DIARIES, &C. .. 677
CURRENT PRICES FOR METALS AND FUELS .. 678
FRENCH ENGINEERING NOTES .. 679
BRITISH PATENT SPECIFICATIONS. (Illus.) .. 679
FORTHCOMING ENGAGEMENTS .. 680

SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST"; AND TWO-PAGE SUPPLEMENT—SANYO CHUO HYDRO-ELECTRIC COMPANY, SHIKAMA, JAPAN—STEAM TURBINE PLANT.



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### The Metallurgist.

THE DECEMBER NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

*Owing to the condition of industry it has been decided that bi-monthly publication of* THE METALLURGIST *will meet present requirements and in consequence it will appear six times in* 1933 *instead of twelve times as heretofore. The next number will be published on Feb. 24th and subsequent numbers in every alternate month. In order to keep pace with any important metallurgical events that may occur in the intervals articles will be printed, as required, in the body of* THE ENGINEER.


## BOILERS AND HEAT PUMPS.

To judge from the correspondence which appeared in our columns some weeks ago, there would seem to be a belief in certain quarters that, by the combination of a heat-pump with a boiler some very extraordinary results might be obtained. No engineer, of course, could endorse the claim which has been made for a possible efficiency of over 100 per cent. unless, like Humpty-Dumpty, he was prepared to "pay his words more and make them mean what he likes." Nor would he accept much more readily the statement that it was possible by any means whatever to get more heat into an isolated boiler plant than the total amount produced by the combustion of the fuel. Nevertheless, once the word "heat-pump" is introduced he may not feel quite so ready to continue the argument. He has never, to his knowledge, seen a heat-pump, but from the fading memories of his early studies he knows that such a device exists, at any rate in theory, and that its performance seemed very wonderful to him at the time. It could get heat out of the air in unlimited quantities and deliver it at a higher temperature, and all for a very small expenditure of energy. Confronted with the suggestion that such a machine could be used as an auxiliary to a boiler plant, taking in heat from the atmosphere and delivering it to the furnace, he may wonder whether, after all, there may not be something in the idea. At all events, the scheme looks plausible. Nor can it be rejected on the grounds that a heat-pump is merely a thermodynamic abstraction like a Carnot engine. It is, on the contrary, a perfectly practical piece of mechanism, which can be constructed and operated in spite of the imperfections inherent in all actual machines. As an example of its possibilities, one of the standard textbooks demonstrates to students that with apparatus of ordinary commercial efficiency 100,000 B.Th.U. may be delivered under certain conditions for a combustion of fuel containing only 10,000 B.Th.U. This sort of thing has, of course, been known for years, the theory of the heat-pump having been explained by Kelvin long before the majority of the present generation of engineers was born.

At the risk of expounding the commonplace we would recall the elementary principles of the heat-pump to those who are tempted by visions of unrealisable thermodynamic gain. Such a device is merely a reversed heat engine and subject to the same laws and limitations. Much more heat has to flow through a heat engine than could be turned into work even if the engine were ideally perfect. Conversely, if we reverse the cycle, using the engine as a power-driven pump, the heat that it will deliver at the higher temperature is more than would be required to drive it. Hence the consumption of a small quantity of heat in the form of power may result in the production of a much larger quantity of heat drawn from the inexhaustible reserves of the atmosphere. Heat being, by the First Law of Thermodynamics, equivalent to work, we should have all the requirements of perpetual motion were it not for the inexorable Second Law, which has ruined the dreams of so many inventors. We can certainly get the extra heat, of that there is no doubt. But even with ideally perfect machinery we can get no advantage from it, and with any actual machinery we are bound to make a loss on the exchange if our ultimate object is the production of power. This should be obvious, for the process would involve the conversion of power into heat and back into power again. If we want to pump heat from the atmosphere into a furnace, no method could be more efficient than causing air to expand isothermally behind a piston, the temperature of the expanding air being maintained constant by heat flowing in from the atmosphere. The air would then be re-compressed adiabatically to atmospheric pressure and delivered to the furnace. If this process be carried out on one pound weight of air, originally at 60 deg. Fah., the air being expanded isothermally to one-tenth of an atmosphere before re-compression, the power theoretically required will be the equivalent of 34·4 B.Th.U. The air, however, after re-compression will be at a temperature of about 550 deg. Fah. instead of 60 deg. Fah. and will therefore carry into the furnace 116·5 B.Th.U. more than it would otherwise have done. Deducting the power required to work the heat-pump we would seem to be making a clear gain of about 82 B.Th.U. for every pound of air so treated. But what benefit can we get from this heat, always supposing that our final object is to obtain power? We have a pound of air at atmospheric pressure and at a temperature of 550 deg. Fah. There is evidently work to be obtained from it by reason of its temperature. We could use the heat to raise steam and thus drive a steam engine, or we could merely reverse the process by which we obtained it, allowing the air to expand adiabatically down to atmospheric temperature and then re-compressing it isothermally to atmospheric pressure. Whatever kind of engine we use to develop the power, we could obviously couple it up to our heat-pump. If, then, there is any advantage in our extra heat, the engine will not only drive the pump, but will produce some power over and above that consumed in driving it. In such a case we should have perpetual motion, which is impossible. The same reasoning, of course, holds whatever temperature the air is raised to by the heat-pump and whatever pressure it is delivered at. It is clear, therefore, that all suggestions that a greater net power can be obtained from a boiler plant by pumping heat from the atmosphere into the furnace are devoid of reason.

Although the question of heat-pumps arose in the correspondence to which we have alluded, it developed apparently from a claim that more heat could be got into a boiler than the fuel would produce, if matters were so arranged that the flue gases were discharged below atmospheric temperature. We dealt with this claim very fully in the article which gave rise to the correspondence, and its baselessness was also demonstrated in the discussion. The fallacy is due to neglecting the fact that the cycle has to be completed. Although the supercooled gases do not themselves travel back to the compressor inlet, a corresponding quantity of fresh matter has to enter the system, so that it is legitimate to imagine a continuous circulation of the heat-carrying medium. Hence we have to take into account the effect of the re-warming of the cooled gases to the temperature of the air entering the compressor. The latter is no longer able to receive the working fluid at the lowest temperature of the cycle, but at a temperature considerably higher, and thus the work of compression is correspondingly increased. To discharge the flue gases at any temperature below that of the atmosphere is, of course, quite possible, but should be avoided for thermodynamic reasons. If, however, anyone likes to try it in the hopes of realising the promised efficiency of more than 100 per cent., we suggest that he should at the same time use the exhaust gases for brine cooling, so as to get ice also for nothing. It is a pity not to do a job thoroughly while one is about it.

### Yesterday and To-day.

FOR centuries man has struggled to understand the universe, and the more he understands, the more he finds there is yet to learn. To all appearance the struggle is likely to continue until the prophecies of the physicists come true millions of years hence, when the sun no longer has the power to warm the earth and the ice age returns to hold the land in thrall for ever. Of what mankind may have discovered by that date and what powers the physicists and engineers may have by then to meet the conditions of existence, it is impossible to conceive. We are concerned with the twentieth century, and with the efforts that our own century is making to contribute its scrap to the sum total of man's knowledge at that date. We have, supporting us, a storehouse of facts and theories collected and propounded by scientific workers of the past, and we endeavour to the best of our ability to approach the problems that confront us much as they approached theirs. Nevertheless, when we look at their achievements we are tempted to declare that ours is the harder task. It was easy, we exclaim, for Joule to prove the identity of heat with work; for Newton to propound his laws of motion; even, to come to more modern times, for Callendar to work out the properties of steam. For we think we see an important difference between our work and theirs. Joule, wishing to prove his point, was able with his mechanism to reduce the number of variables to one; to that one, in fact, the work, which he believed was identical with heat; and so by varying that variable to show that the heat produced varied in proportion. We, however, are confounded when we try to put similar principles into practice, by finding that in many a problem the variables are not amenable to such convenient treatment. We wish to discover the mass of an electron, and behold! it varies with the velocity; and if we think by measuring the velocity thus to discover the mass, we are confuted by finding that we cannot measure the velocity without first determining the mass. How, we are tempted to wonder, Would Newton face such a poser? In many present-day investigations similar problems must be met, and in some cases the number of variables concerned seems so great as to defy analysis. Meteorology has made great strides in the last fifty years. Yet from the knowledge gathered laboriously by more than a century of persistent observation, the meteorologist can only forecast the weather, with any pretence of accuracy, for a day and a night, or under particularly favourable circumstances for a period twice as long. The vagaries of cyclones defeat him if he is rash enough to stake his reputation on a more enduring forecast. Cyclones follow no defined path; move with no defined velocity; originate in no closely defined area. There is doubt as to whether all the variables that affect their movements have yet been discovered. In less general phenomena, there appears to be some connection between electric storms and sunspots, but the exact significance of the relation is mysterious. Even the prediction of the occurrence of a fog, the mechanism of which is known, is fraught with difficulties. In every case the number of variables is so great as to make prediction hazardous, while it appears to be beyond the powers of science to control sufficient variables to make an examination of the remainder possible.

It is not only in physics and meteorology that the task before the scientists of the present-day seems

harder and more involved than that of their progenitors. Many problems that appear to be as difficult to solve confront the engineer. Within the last twenty years mechanically propelled vehicles have developed so much as almost to outreach the power of the engineer to construct and maintain the roads. In an endeavour to learn something of the behaviour of roads, a Committee was set up two years ago to study and experiment. But, like the meteorologists, that Committee is hampered by the difficulty of separating out the effects of the numerous variables involved. It has done valuable work in suggesting methods of testing road surfacing materials in the laboratory, but the meaning of those tests is sometimes obscure. To quote from the pages of a report recently issued by the Committee, and in reference to a tensile test, "This test may possibly measure the capacity of the material for resisting the tearing action of mechanically propelled vehicles upon the surface, but the interpretation of the results requires further consideration." Unlike the tensile tests of a steel rod, which may be used as a tie-bar, that of the bitumen for road surfacing has no direct relation with the stresses it will have to bear when in use. It is, in fact, hard to see how the influence of tensile strength alone on the bitumen's performance on the road is to be separated from its many other properties. In the traditional manner, the Committee has decided—how else could it decide?—to collect data by actual observation of road surfaces. But it is difficult by this method of investigation to take into account and set in correct proportion the effect of such variables as rain, hail, snow, heat, and frost, to make no mention of either the effects of various types of traffic under such weather conditions or the variable nature of the foundations. It is, we think, unnecessary to point out the many fields of endeavour in which the engineer has to meet such problems, wherein the variables are numerous and as to the majority outside his control. For such investigations the scientific method of holding fixed for the nonce all the variables save one, and thus discovering the influence of the latter, seems inapplicable.

At first sight it may seem that many of the problems which now engage our attention are altogether insoluble, and that for others only an empirical solution will be found. It is, no doubt, true that many of the investigations upon which mankind is at present engaged will never be suitable for mathematical analysis. But for many of the problems that we now class among the insolubles a future generation may find a simple solution. Was it, for instance, easy for Joule to penetrate into the mire of hypotheses that surrounded the mysterious quality called heat and to recognise, thus obscured, the essential relations between temperature, total heat, and work—to realise, for instance, that although the amount of light given out by a hot body varied with the temperature, this variable had nothing to do with his problem? Was it really so simple for him to realise that of the many possible variables it was only necessary to make provision against radiation losses? Had not Copernicus, before propounding the theorem that led Newton later to that of gravitation to dig until he found the truth through all the complication of Ptolemaic epicycles? And did not Newton himself have to rid his mind of the load of many an inconvenient variable before he could propound the law of gravitation? So may we discover with our latter-day science that many of these variables that seem to us of such great importance have no real effect upon the main problem or by continual observation we may, by approximation after approximation, detect at last the single or combined effect of every variable.

## Obituary.

### ARCHIBALD GILCHRIST.

IT is with deep regret that we have to announce the death, after a short illness, of Mr. Archibald Gilchrist, the chairman of Barclay, Curle and Co., Ltd., of Whiteinch, Glasgow, and the President of the Institution of Engineers and Shipbuilders in Scotland. The loss to the Clyde shipbuilding industry is indeed a severe one, especially in view of the deaths during the last few weeks of Sir Frederick Lobnitz and Mr. Fred J. Stephen.

Archibald Gilchrist came of a famous family of shipbuilders and engineers who for over three-quarters of a century have been connected with the Barclay-Curle undertaking. He was born in Glasgow, and following his educational years, was apprenticed with the firm of Muir and Caldwell. He also served some time in the Pembroke, Devonport, and Portsmouth dockyards, and then gained drawing-office experience with the Clydebank firm of J. and G. Thompson, now John Brown and Co., Ltd., and with the Central Marine Engine Works of William Gray and Co., at West Hartlepool. After these years of shore training young Gilchrist spent some time at sea in the Indian service, and thirty years ago he joined Barclay, Curle and Co., as assistant general manager. He eventually succeeded his father, the late Mr. James Gilchrist, as engineering managing director. When in January, 1931, he was appointed the chairman of Barclay, Curle and Co., Ltd., he recalled that it was in 1854 that his grandfather, Mr. Archibald Gilchrist, first became a partner in the business, which was founded in 1818 by Robert Barclay at Stobcross. His grandfather became chairman in 1857, and in 1900 was succeeded by his son, Mr. James Gilchrist, who died in 1917.

Archibald Gilchrist was largely responsible for the construction of the machinery for the first ocean-going motor vessel built on the Clyde, the "Jutlandia," which went to sea in 1912, and since that time he took the greatest interest in the oil engine side of the firm's business. During the war he was actively engaged in the production of all types of warships, commercial ships, aeroplanes, seaplanes, and field guns. For this work he was awarded the Order of the British Empire in the year of its inception. In more recent times Mr. Gilchrist took the greatest interest in the consolidation of the firm's various establishments, and one of his particular schemes was the construction of the new graving dock at Scotstoun. For many years Mr. Gilchrist was a director of Swan, Hunter and Wigham Richardson, Ltd. He was a member of the Executive Council of the British Oil Engine Manufacturers' Association and also a member of the Institution of Naval Architects and of the American Society of Naval Engineers. From 1928 to 1929 he was President of the Glasgow University Engineering Society. His loss will be keenly felt by the Management and Technical Committees of the British Corporation Register of Shipping and Aircraft, of which committees he was a member and a representative for the Institution of Naval Architects. He was re-elected last year to be President of the Institution of Engineers and Shipbuilders for a second term of office.

## Literature.

*Recent Advances in Atomic Physics.* By GAETANO CASTELFRANCHI. Approved Translation by W. S. STILES, Ph.D., and J. W. T. WALSH, D.Sc. Vol. I., "Atoms, Molecules, and Electrons"; Vol. II., "Quantum Theory." London: J. and A. Churchill. Price 15s. each volume.

THE expanding of the boundary lines of scientific knowledge into regions regarded only a few years ago as unfathomable or beyond a possibility of experimental demonstration, has been nowhere so great as in the realm of atomic physics. The period since 1924 has been highly prolific in furnishing foundations on which to build our conceptions of the physical universe. To-day, the theory is generally accepted that the material universe is made up of atoms, though it is not manifest to the senses that matter is discontinuous. The atom is now known, not merely to have reality, but to possess a definite structure and to consist of electrons with a minute central nucleus. Extensive studies have been carried out relating to the nature of atomic structural arrangements, and have met with considerable success, and the results have been applied to the experimental facts of chemistry. Natural laws are substantially statistical in character, hence the study of atomic structure necessarily involves not only the newer profundities of physics, but also a clear understanding of the implied mathematical development.

Perhaps there is no achievement which more clearly brings into focus the power of modern physical methods than our ability to detect and define the effects produced by a solitary atomic projectile or a single electron. The most striking results in this direction are those obtained by C. T. R. Wilson at Cambridge, who has been able to render the track of the atom visible provided it is moving with sufficiently great veolcity. During the last few years considerable progress has taken place in the theoretical and experimental study of the structure of the atom, and the energy changes which accompany atomic transmutation. The results of these investigations have materially aided in explaining and correlating many of the fundamental facts of physical and chemical science. The main discoveries relating to atomic physics have inspired remarkable developments, and have produced abundant speculations regarding the constitution of the atomic nucleus. We now know that Nature uses the same standard material in the construction of the atoms of all the elements and the standard material is the primordial atom of positive and negative electricity, protons, and electrons. The attempt to interpret the difficulties of modern atomic physics along the lines of wave mechanics, has been prosecuted with a considerable measure of success by the ingenious speculations and experimental researches of de Broglie, and further developed by Schrödinger, both of whom have taken an active part in the development of the ideas which distinguish modern from classical physics. More recently an extension of wave mechanics by Gamow, Gurney, and Condon has opened the way to a theory of the nucleus and of radio-active change.

Following on the discovery of the electron by Thomson, the development of the quantum theory by Planck, Bohr's scheme of spectra and the studies of Lord Rutherford relating to $\alpha$ particle deflections, it was considered a few years ago that the position of atomic physics which for a considerable time had been very largely in a state of flux, was gradually crystallising into a state of stability. However, more recently, in view of the wider applications of the conceptions of quanta, relativity and wave mechanics, it has been found necessary to modify our outlook relating to conceptions of matter, energy, space, and time, owing to the discovery of a number of experimental facts which cannot be reconciled with previous theories. The more important of these are the necessity for using fractional quantum numbers in order to explain band spectra, anomalies found in the analysis of the complex Zeeman Effect, and in the more recent studies relating to the reflection of electrons by atoms. In order to interpret and resolve some of these anomalies, Bohr brought forward his Correspondence Principle. Alternatively, an attempt has been made by Dirac along the lines of the new mechanics. It has been shown that Bohr's theory is not only a physical interpretation of the Balmer-Ritz spectral formula in terms of Rutherford's atom, but it has become of fundamental importance in the interpretation of radiation, catalysis, photo-chemistry, has outlined the architecture of complex atomic structures, and led the way towards the discovery of the new element Hafnium.

Recent progress in atomic physics is well portrayed in the two volumes under review. In the present volumes, based on the third Italian edition, the method of treatment has been slightly changed, and new sections have been incorporated dealing more particularly with photo-electric cells, the new theory of radio-activity, the discovery of para-hydrogen, and television. During translation Drs. Stiles and Walsh have deemed it advisable to omit Chapters IV., VI., and XXI. of the third Italian edition, chapters which in the original text deal respectively with the Brownian Movement, Relativity and Mass, and Astrophysics. Incidentally, the chapters dealing with the Stark and Zeeman Effects, and Wave and Quantum Mechanics have been somewhat abridged during the translation. We have noticed but few errors, but we would mention that Jordan is given as Gordon on page 3 of Vol. I., but correctly quoted elsewhere.

The first volume is devoted exclusively to atoms, molecules, and electrons. After a short introductory chapter, the author proceeds to discuss Fresnel's wave theory of light, the Doppler Effect, and the general properties of radiation. After chapters dealing with electrons and isotopes, an excellent summary is given of the development of X-rays and X-ray tubes, and of the brilliant researches of Moseley—alas, killed at the early age of twenty-five in the Dardanelles campaign in the World War—who made a systematic study of the emission of Röntgen rays as related to the periodic arrangement of the elements. A later chapter is devoted to an account of Debye and Scherrer's method of Crystal Analysis, and to the pioneer work of Laue and Bragg on crystal structure, which have led to an intensive study of the mechanics of the lattice, the energy involved in its dissociation into ions and its formation from the elements. The final chapter gives prominence to Lord Rutherford's experiments on the artificial atomic disintegration and the photographing of the explusion of protons by Blackett. Vol. II., which is devoted to the Quantum Theory, commences with an account of the historical development of the theory, and after a well-prepared *résumé* of the Stark and Zeeman Effects and Pauli's Exclusion Principle, proceeds to deal with photo-electric cells and their practical application in photometry, in the transmission of photographs at a distance, in television, and in sound kinematography. Subsequent chapters deal with the Compton Effect, a phenomenon completely in accord with the corpuscular theory of optics or with the theory of light quanta as proposed by Einstein; wave mechanics and quantum mechanics; and a final chapter devoted to a study of the new statistics and their applications, prominence being given to the researches of Fermi and Dirac, a comparison of the statistics of Boltzmann and Fermi, and a critical survey of the Bose-Einstein statistics and their relationship to those of Boltzmann and Fermi.

The author has surveyed the field of atomic physics with extraordinary thoroughness, the concentration of the mathematical and physical data has been skilfully done, and it is obvious that progress in this realm can only be achieved by those who combine experimental skill with a comprehensive grasp of the powerful probing methods of mathematical physics. Whatever may be the ultimate fate of the newer conceptions of the structure of matter, there can be no doubt of their accuracy, and of their power in correlating a vast number of hitherto little-understood phenomena. The careful and measured state-

ments of the author provide us with ample scope for reflection, and all interested in atomic physics will find these stimulating volumes a valuable guide in this wide and prolific field of scientific discovery.

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*Ripper's Steam Engine Theory and Practice.* Eighth edition. By W. J. GOUDIE, D.Sc. London: Longmans, Green and Co. 1932. 25s.

THIS is a very welcome revision and enlargement of Professor Ripper's well-known text-book, the last edition of which appeared in 1914. It has been extended and largely rewritten by Professor Goudie, the book having grown to a substantial volume of 841 pages, with over 500 figures.

It is sometimes thought that the reciprocating steam engine had some time ago reached the limit of its development. The error of such an idea is evidenced by the large amount of new matter relating to this type of engine that Professor Goudie has found necessary to include in order to bring the volume up to date. Exigencies of space put a limit to the description of engine types, but the characteristic features of high-speed engines, Corliss, drop valve and uniflow engines are described, and the uses of back pressure and extraction engines are discussed, with calculations of their steam consumptions. The progress of the steam turbine obviously has provided cause for a great extension of the chapters on that prime mover.

The book is intended primarily for students, so that thermo-dynamic principles and methods of calculation are discussed in considerable detail and with painstaking lucidity. The principal details of construction, the action of steam in the cylinder, compounding, governing, balancing, &c., are adequately dealt with. As was to be expected from Professor Goudie, the chapters on the steam turbine, its principles, chief types, thermo-dynamics and design calculations are very competently written.

The properties of steam are discussed in the light of the most recent researches, extracts from Callendar's 1929 tables are given, and in all examples involving steam properties, the modern values are used and the modern treatment of internal energy, external energy, and total heat is followed. The use of logarithmic scales for the analysis of indicator diagrams is explained and illustrated.

The student will find this an excellent text-book, reliable and systematically arranged. A special feature is the inclusion of a large number of numerical examples, worked out in exhaustive detail. The reader who has followed them through—as none but the idle or incompetent need be unable to do—will have acquired a sound and comprehensive knowledge of the modern steam engine and steam turbine in so far as it is possible to do so apart from practical experience.

The value of the book is not limited, however, to students alone. The engineer of maturer years will find it useful for its descriptions of recent developments, such as, for example, the Caprotti valve gear, the Bauer-Wach combination of reciprocating engine and turbine for marine propulsion, the regenerative condenser, and the high-pressure locomotives of Gresley (the L.N.E.R. "No. 10,000"), Schmidt and Schwartzkopf, as well as for its survey of modern engine and turbine theory and practice.

References to original sources of information are freely given, a very commendable practice.

There is little in the book that calls for criticism. The statement on page 170 that the loss of heat from an uncovered pipe is inversely proportional to its thickness is erroneous; doubling the thickness would not halve the loss. In the descriptive sections, it is a matter for regret that prominence is given to Continental designs while suitable examples from British practice are either ignored or barely mentioned in footnotes. Thus, for the hydraulic method of operating engine valves, a foreign design is described, but the British Galloway-Pilling gear is omitted. Also the engines chosen to illustrate the back-pressure and extraction types are foreign, though British practice could provide equally suitable examples.

Nevertheless, the book is an excellent one, and Professor Goudie is to be congratulated on the manner in which he has performed his task.

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*Modern Materials Handling.* By SIMEON J. KOSHKIN. London: Chapman and Hall, Ltd. 1932. Price 37s. 6d. net.

THE object of this work, as expressed by the author, is to deal with the main principles involved in the choice of handling equipment and to indicate, by means of typical examples, the many uses to which such equipment may be adapted. It is really the outcome of a series of lectures delivered by the author at Cornell University, and he has succeeded in condensing a vast subject within the space of a comparatively small volume.

The first chapter deals with the theoretical aspect of the subject—the principles involved in classification and analysis—and is in itself an apt summary of the views and methods of American handling specialists. Dealing first with cranes of various types, the theme of overhead transportation, embracing aerial ropeways, cableways, and slack-line excavators, is discussed. *Apropos* of various subjects extracts from the works of recognised handling experts have been introduced where applicable. All these quotations are clearly indicated, and, *ipso facto*, give the book a distinct value as a work of reference.

The section on belt conveyors is very comprehensive, and a reader can gain a clear impression as to the design and construction best suited for any particular purpose.

The title of the book is not altogether well chosen, since it is all-embracing, whereas pneumatic handling, which is perhaps the most important of modern developments, has been omitted.

Since the intention of the author was to refer only to the usual standard types of devices, he has made no mention of the steel belt conveyor, and its importance in the preparation of foodstuffs; nor of the Cutler-Hammer or Igranic conveyors, which are extensively used in newspaper production; neither has he mentioned the latest methods of conveying powdered substances. All these are generally regarded as standard types in this country.

The numerous illustrations show typical examples of American practice, including standard types of elevators and conveyors, and examples of overhead and floor equipment, mostly of plant in actual operation.

In a number of instances these illustrations have been grouped together, and reduced down to full-page plate, being lettered for easy reference. It is rather a pity that, in some instances, the illustrations are so small, probably, however, considerations of space necessitated this.

The index is comprehensive and gives evidence of having been carefully prepared. The reading matter is presented in an attractive form, and—except, perhaps, in the case of the Crane section—no unnecessary matter has been included.

The volume should prove a useful handbook for those who seek to obtain general information on the subject of materials handling. It will probably appeal most to works managers and factory engineers who wish to obtain an all-round knowledge of mechanical handling devices.

In subsequent editions we look forward to seeing its value greatly enhanced by the inclusion of references to English and Continental experience.

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*Steam Power Plant Engineering.* By L. A. HARDING, B.S., M.E. New York: John Wiley and Sons, Inc. London: Chapman and Hall. Price 62s. 6d.

THERE are books on steam plant which are written for the instruction of students and in which, therefore, calculations and principles of design are carefully related as far as possible to the underlying scientific principles; others, more advanced or more specialised, are written to expound the author's own theories or practice; others, again, are compilations of information, of formulæ largely empirical, and of tables of data and dimensions from current practice, so that they have more of the nature of a book of reference than of a treatise. This book is of the last-named type, and the practice reflected in it is almost exclusively American. To the reader of the "Transactions" of the American Society of Mechanical Engineers much of the contents of this book will be familiar. Extracts from the publications of manufacturing firms or trade associations form a large proportion of the remainder. Indeed, it is seldom that in a volume which claims to be a text-book the personal views of the author are placed so completely in the background.

It is a large volume of nearly 800 pages, with numerous illustrations and copious tables representing manufacturers' lists of their standard designs and tables of particulars and data relating to the equipment and performance of American power stations. The author's aim is to discuss in outline the entire plant concerned in the combustion of fuel for the generation of steam and in the production of power by a steam cycle. Boilers, of the water-tube type in particular, with mechanical stokers and auxiliaries, such as mechanical draught fans and chimneys, are fully described, but the chapters on steam engines and turbines are ill-balanced. Piston drop valves are not mentioned at all, and the modern double-seated drop valve is just mentioned without having any particular attention given to it. Trip valve gears are represented by only one example of a Corliss gear. The steam turbine chapter, after a few historical references, switches into general remarks as to the suitability of the turbine for power stations, and then into a long description of turbine arrangements, and particulars of turbo-alternator practice, and only afterwards does the author explain what a turbine is, and what are the principles of its design.

Piping and valves, the heat balance in power stations, and the economic factors in power station design, are dealt with at some length. The chapter on piping in particular, dealing as it does with flexibility of pipe bends, expansion stresses and anchoring of pipe lines, summarises much of the copious American literature on those subjects on which very little has appeared in English technical books. To the British reader the rating of boilers and boiler auxiliaries in horse-power is unfamiliar and a little irritating. The author himself states that "custom and usage are the only factors in favour" of the retention of the term boiler horse-power, and quotes the finding of the A.S.M.E. Committee on Definitions and Values of Power Test Codes in favour of heat output or evaporation in pounds of steam per hour as the measure of boiler output. Nevertheless, he uses the boiler horse-power unit throughout most of the book, and it is the unit quoted in the manufacturers' tables of pumps and other auxiliaries.

The book is more empirical than scientific and not, therefore, a very good one for students' use. For those, however, who wish to have a comprehensive view of American steam power station practice, reflecting the very voluminous papers presented to the American Society of Mechanical Engineers, and to other American periodic literature, as well as the standardised practice of American makers of stokers, fans, condensers, and auxiliaries, the whole being brought right up to date and furnished with full references to the original sources of information, it will be of service.

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*Flotation Plant Practice.* By PHILLIP RATHBONE. 1932. London: Mining Publications, Ltd. Price 10s. 6d.

THIS small book has been written with a very definite object, as stated by the author in his preface, it having been "designed to give the general engineer and student a broad conception of the subject with no more detailed information or theory than was necessary for the purpose." It may be said at once that this object has been quite well attained. The book consists essentially of seven chapters, each devoted to one particular aspect of the subject. The second and third chapters, devoted to crushing and grinding respectively, are, perhaps, the most important, and those to which the author appears to have given particular attention. In this he is undoubtedly right, because flotation, or, indeed, any process of concentration, can only be successful when the crude mineral is ground fine enough to liberate the mineral constituent which it is desired to concentrate. In this particular case, however, the author points out that grinding to an even finer stage than this is requisite for successful flotation, this being essentially a surface action. It is to be regretted that the book nowhere indicates that this process is an essentially British invention, although it has been energetically taken up and largely developed in America. The author devotes a chapter to flotation machines, but, apparently, describes only those used in the United States, and does not even refer to such machines, though largely used on the Continent of Europe, as the Kleinbentink, the Ekof or the Gröndal.

All through the book the author, apparently, confines his attention to the flotation of metalliferous minerals; it is true that he states that "graphite sulphur, and even coal" can be concentrated by flotation, but gives no indication that he is aware of the large extension of this method of coal cleaning. Finally, it may be pointed out that he throughout uses the term flotation as being synonymous with froth flotation, although the student, at any rate, should bear in mind that other methods of flotation do exist, though their importance is entirely overshadowed by that of froth flotation, to which this book is dedicated.

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## BOOKS RECEIVED.

*Good Investing.* By K. Adlard Coles, M.A. London: Jordan and Sons, Ltd., Chancery-lane, W.C.2. Price 2s. 6d. net.

*Power Economy in the Factory.* By J. C. Todman. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 7s. 6d. net.

*A.S.T.M. Tentative Standards*, 1932. Philadelphia: American Society for Testing Materials, 1315, Spruce-street, Pa., U.S.A. Price 7 dollars net.

*Jane's Fighting Ships*, 1932. Edited by Oscar Parkes, O.B.E., &c. London: Sampson Low, Marston and Co., Ltd., 100, Southwark-street, S.E. Price 42s. net.

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## COL. BATTYE MEMORIAL FUND.

A MEMORIAL fund has been opened in Lahore, Punjab, for procuring a bronze tablet to the memory of the late Col. B. C. Battye, D.S.O., R.E., Chief Engineer of Punjab Hydro-electric Undertaking. The tablet is to be erected in the power-house at Shanan, which is now approaching completion. It has been suggested by members of the Memorial Fund Committee in Lahore that friends and admirers in Great Britain would welcome an opportunity of contributing to the fund, and a local sub-committee to receive donations has been formed. Contributions may be sent to Mr. S. B. Donkin, c/o Messrs. Kennedy and Donkin, Broadway-court, Broadway, Westminster, S.W.1; or to Mr. E. Parry, c/o Messrs. Preece, Cardew and Rider, 8, Queen Anne's-gate, Westminster, S.W.1, and marked "Col. Battye Memorial Fund." It is estimated that a total sum of £200 has to be raised and individual contributions are limited to £1.

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AN investigation carried out by the Illinois University of Engineering on the economies of mine ventilation shows that the greatest opportunities for effecting economies are to be found in those parts of the mine where the air is forced to move with the greatest speed.

## 1,500,000 kVA Alternator and Switchgear Testing Plant.

THE safety of every electrical power system depends upon the proper functioning of its circuit breakers, for should one of these fail the consequences might well be disastrous. With the very large powers now handled by central stations and sub-stations, the reliability of circuit breakers is more than ever important, as they may be called upon at any moment to isolate one or more of the main generators or some part of the transmission system automatically, safely, and in the fraction of a second. The crucial test of a circuit breaker is its behaviour in the event of a sudden short circuit when the whole power of a central station may be pouring into the fault an enormous current which has to be instantly interrupted. How a breaker would comport itself under such conditions is a matter which, until recently, engineers have had to take on trust, at least until a bad short circuit actually occurred. The manufacturers of such apparatus could only justify their designs by the results of tests carried out on the smaller sizes and with limited powers, and, though actual happenings taught them many valuable lessons, no new design could be considered really reliable until it passed safely through the ordeals which only service could provide.

Such a state of affairs could not be regarded as satisfactory. It was not reasonable that one of the most vital elements of a power system should escape from the salutary rule that every important piece of apparatus should be tested under the most extreme conditions of service before being called upon to fulfil its duty. Moreover, the principle that advances in practice should depend so much on the risks that users were willing to take was not a sound one, for progress was retarded, and what information could be gained from failures was necessarily incomplete. To assist designers with accurate data, the British Electrical and Allied Industries Research Association carried out much valuable work on circuit breakers at Carville. This work, however, was limited by the equipment, for the 6000-kW alternator at the disposal of the Association could not furnish the power for a full capacity test, even of a normal high-voltage sub-station breaker. More powerful testing equipments were available abroad, and it was evident that if British manufacturers were to retain its lead in switchgear design and to continue to enjoy the confidence of users, a really adequate testing plant was urgently needed.

The construction of such a plant was bound to be a costly undertaking, and several schemes were suggested by which the firms interested in switchgear manufacture should carry it out on a co-operative basis. Nothing, however, came of these schemes. Some three or four years ago, therefore, A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, determined to wait no longer. They decided, on the initiative of Mr. H. W. Clothier, the managing director of the company, to put down a complete switchgear testing plant for their own use, capable of testing the very largest circuit breakers likely to be called for. To enable this to be done it was necessary to provide generating machinery capable of producing no less than 1,500,000 kVA on short circuit, this being generally accepted as the highest capacity for which electricity supply undertakings will lay out their plant in Great Britain. The nature of this machinery needed careful consideration. A modern switchgear testing plant in the United States, with a short-circuit capacity much less than that proposed by Messrs. Reyrolle, obtains its power from two generators of the slow-speed type, operated in parallel. The employment of two generators of relatively small capacity was also considered by Mr. Clothier, but in view of the extra complications which such a practice would involve, he decided to produce the whole 1,500,000 kVA by means of a single turbo-alternator if a machine of this capacity could be obtained. C. A. Parsons and Co., Ltd., of Newcastle-on-Tyne, thereupon undertook to build one which should not only fulfil the electrical requirements, but would further possess an amount of kinetic energy equal to that of several smaller units running in parallel and developing the same aggregate kVA. This last feature was of particular importance, for it enabled the testing alternator to reproduce the same short-circuit conditions as would obtain in an actual central station with several machines on the bars. Another characteristic secured in the design was that of a specially low reactance. The rotor, constructed of a solid forging, was fitted with heavy damping bars, which gave the machine the short-circuit decrement of a modern commercial alternator. The internal losses were also minimised, thereby rendering the maximum energy available for dissipation in the apparatus under test.

A photograph of the 1,500,000-kVA unit, as it appears in the test house, is reproduced in Fig. 1, page 668. The machine runs at 2400 revolutions per minute, being driven by a 5500-volt motor taking its power directly from the mains. To prevent the disturbance of the supply system which would otherwise arise every time the alternator was used for a short-circuit test, the current to the motor is automatically disconnected an instant before the short circuit is applied, power being again restored the moment that the short circuit is cleared. The exciter for the alternator is mounted on the end of the shaft. The weight of the complete unit is about 120 tons, and it is bolted down with exceptional firmness to a concrete foundation weighing another 250 tons.

The stator casing and the bed-plate are of welded steel construction, giving greater strength than cast iron to resist the large and sudden forces to which the machine is subjected. The alternator is arranged to give its output at either of four different voltages, namely, 22,000, 12,700, 11,000, and 6350 volts. These are obtained by coupling the stator windings in series-star, series-delta, parallel-star, and parallel-delta respectively. The connections are readily changed by means of links provided for this purpose in the terminal box.

The solidity of the stator construction will be evident from Fig. 5, which shows the machine partly erected. The windings, both of stator and rotor, are insulated throughout with mica. Ventilation is provided by a motor-driven fan external to the machine, the air being drawn from outside the building. It is cleaned by passing through a viscous air filter, and, after cooling the alternator, is discharged inside the house. Since the duration of the short circuits is so brief, less cooling of the machine is necessary than in the case of an ordinary alternator. Hence the volume of the internal air ducts need not be made so great. The space thus saved affords room for a greater quantity of laminations and copper, so that the active material is increased, and at the same time an unusually strong and compact construction is obtained.

Particular attention has been paid to lubrication because the plant is only required to work intermittently, and frequently has to be started up when everything is cold. Provision is therefore made for heating the oil, when necessary, before starting, as well as for cooling it when running. Immediately before starting, oil is forced under all the journals at a pressure of 1000 lb. per square inch, by means of a hand pump. This raises the shaft out of metallic contact with its bearings and permits the heavy rotor, supported on an oil film, to start practically without friction. The driving motor can thus get it into motion easily without the gearing which would otherwise be necessary to start so large a rotating mass. The ordinary oil circulation when the machine is running is maintained by an electrically driven pump, but since the machine, once up to speed, takes about half an hour to come to rest, a stand-by petrol-driven pump is provided to keep up the oil supply in the case of failure of the electric power. Any stoppage of the oil circulation is immediately notified by a contact-making pressure gauge, and each main bearing is further fitted with a thermostat which gives both visual and audible warning in the control room of any undue rise of temperature.

The switchgear testing plant, of which the 1,500,000 kVA alternator above described constitutes so important a feature, is laid out and equipped in a manner which leaves nothing to be desired, either from the scientific or practical point of view. By its construction Messrs. Reyrolle have not only provided themselves with unrivalled facilities for the testing of all kinds and sizes of circuit breakers, but have, in fact, at the same time a laboratory for full-scale switchgear research. The plant occupies a site adjoining the company's New Town Works, with convenient railway connections for transporting the large apparatus to be tested. The site is, of course, completely fenced in and impossible of access to any but authorised persons. It contains, besides the test house proper, a separate control house from which all operations are carried out during a test and where all results are automatically recorded. It will be realised that when enormous circuit breakers are being tested sometimes to destruction, the danger in the vicinity may be very great; hence the test house and control house are separated by a lawn 50 yards in width. The control house, moreover, presents to the test house a blank concrete wall, unbroken save for half-a-dozen narrow observation slots, which will be referred to later.

The test house is divided into a number of separate rooms, the largest of which contains the banks of reactors and resistances for adjusting the short-circuit kVA and the power factor for any particular test. The interior of this room is seen in Fig. 2, part of the end of the 1,500,000-kVA alternator being visible in the picture. Fig. 3 shows another room containing the electrically operated short-circuiting switch. The main current carrying connections in the test house have a cross section of 3 square inches and will safely pass 300,000 ampères for one second. For heavy current testing a Parsons low-voltage transformer capable of giving 600,000 ampères on short circuit has been installed. Round the walls of the low-voltage transformer room are bottles of carbonic acid under pressure, by means of which the whole of

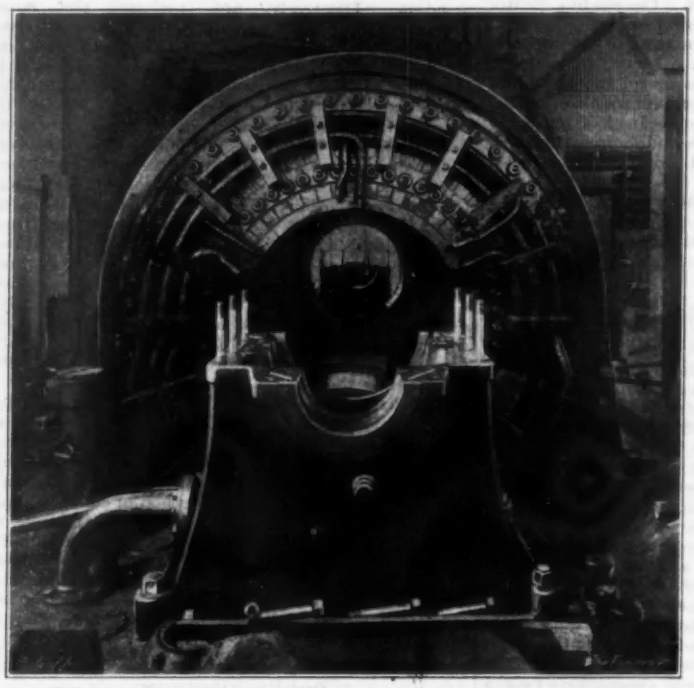


FIG. 5—ALTERNATOR STATOR IN COURSE OF ERECTION

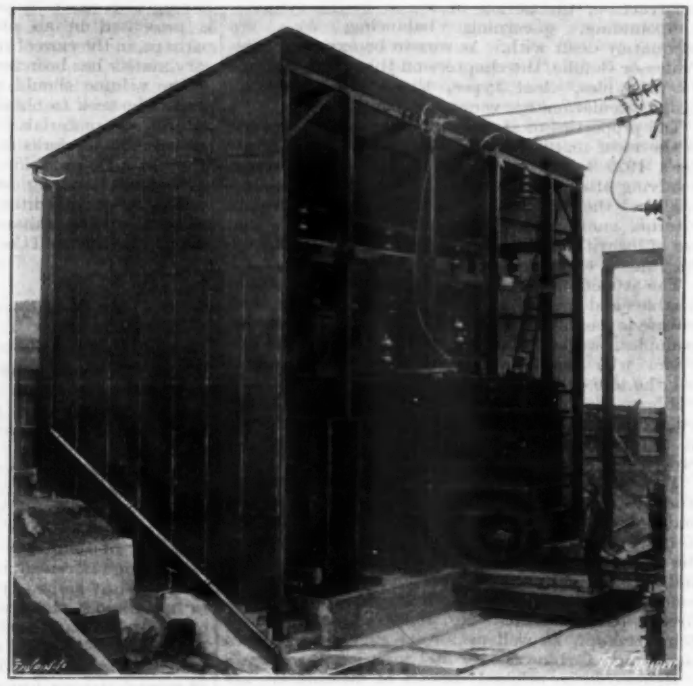


FIG. 6—ERECTING 13,700-kVA SINGLE-PHASE TRANSFORMER

the test bay can be filled with gas within thirty seconds. This precaution is obviously necessary, since, when oil switches are tested to destruction, there is always the possibility of a large outbreak of fire. The gas can be released either by electrical means from the distant control room or locally by either remote control or direct hand operation. The alternator and the terminal pit can also be flooded with carbonic acid gas. Small oil fires are extinguished by portable equipment fed from the main gas supply by a convenient system of piping. To test the efficiency of the main fire-fighting equipment 120 gallons of heated and blazing switch oil were upset on the floor of the test bay. The door was then shut and the bay flooded with gas by an operator in the control room. Within fifteen seconds of the order to close the door the fire was completely extinguished and subsequent examination showed that the damage was negligible

When everything is ready for a test and the alternator is up to speed the whole of the staff leave the test house and report to the engineer-in-charge at the control room. The doors are then locked and traffic signals forbid any approach. Indeed, unless the test house doors are locked the 1,500,000-kVA alternator cannot be excited. The circuit breaker to be tested is erected in a bay at the end of the test house facing the control room. The sliding iron door of the bay is open and the breaker stands in the full glare of a number of projectors so that every detail is visible from the control house. The observers stand in a gallery in the latter and peer through the narrow slots—Fig. 7—above mentioned, safe from the consequences of any explosion that might occur.

The test commences by the closing of the protective interlocking circuit. The alternator is next excited and regulated to the required voltage. The engineer-in-charge then closes the master control switch, which by its movement sets in motion a timing pendulum. The passage of this pendulum over successive contacts controls the sequence and duration of the whole of the subsequent train of events in accordance with the requirements of the particular test being carried out, nothing being left to human agency or judgment.

A photograph of the instrument room in the control house is reproduced in Fig. 4. In the foreground are the oscillographs, supplied by the Cambridge Instrument Company. There are three cameras, one for each phase, so that everything which happens in a switch from before the short circuit until after the current has been completely interrupted is permanently recorded. These oscillograph records are of wonderful interest, besides being of the highest practical importance. A further record of every single test which is carried out is obtained by a cinematograph apparatus, the flood-lighting of the breaker under test rendering this possible. Thus a film is obtained from which every stage in the destruction of the switch, should it be destroyed, can be examined at leisure. The control house is provided with its own photographic room, where the films and oscillograms can be developed immediately after being taken. An adjacent cinematograph room enables the cinematograph records to be projected on a screen for the instruction or interest of those concerned.

Fig. 7 is a view of the test house as it appears to an observer looking through one of the slots in the wall of the control house. The photograph, of course, makes the distant test house look far smaller than it appears to the naked eye. On the left of the test house is seen the transformer house, where a bank of Parsons transformers is installed to enable three-phase circuit breakers to be tested at pressures up to 67,000 volts. A nearer view of the transformer house, showing one unit being placed in position, is given in Fig. 6. These transformers also allow the testing of single-pole units of three-phase circuit breakers rated up to 1,500,000 kVA at 132,000 volts.

Since the 1,500,000-kVA alternator was put into regular service in March last over 2000 short circuit tests of circuit breakers have been carried out by its means, many of them at or very close to the maximum rating of the machine. A recent examination of the plant showed all parts to be in excellent condition, no sign of movement or deterioration of the stator windings being discoverable. The operation of the machine is so simple that the testing staff treat it merely as a piece of apparatus controlled by push buttons, and can concentrate their attention on the test itself. So handy is it and so well organised the routine that as many as sixty short circuit tests have been carried out in a single day. There is, moreover, no other switchgear testing plant in the world equipped with a turbo-alternator for the production of the power required, such other plants as there are depending on slow-speed alternators. Hence in this respect also Messrs. Reyrolle's plant is unique.

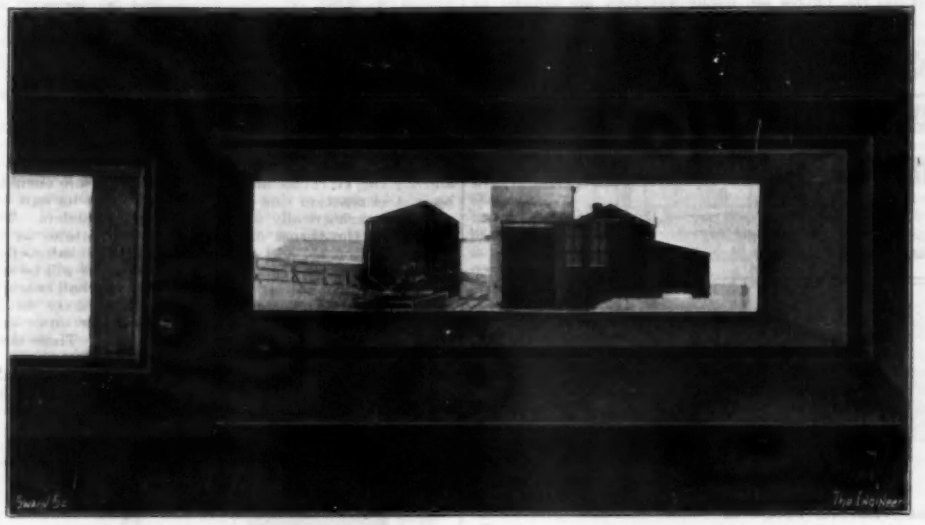
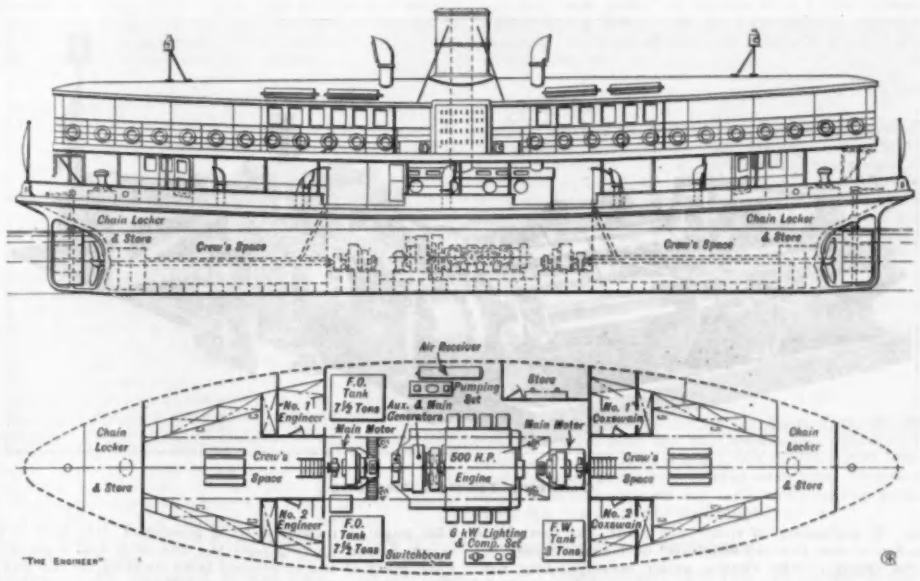


FIG. 7—TEST BAY SEEN FROM OBSERVATION GALLERY

## An Oil-Electric Ferry-boat with Horizontal Engines.

IN the accompanying drawing we illustrate an oil-electric ferry-boat, which is being constructed at the yard of the South China Motor Shipbuilding and Repairing Works for the Star Ferry Company's Hong Kong–Kowloon service. It will be propelled by a 500 B.H.P. Crossley-Premier *vis-à-vis* type horizontal oil engine, driving a 300-kW B.T.H. generator, which will deliver current to two 370 B.H.P. propelling motors. The general arrangement of the ferry and her machinery will be clearly seen from the upper and lower drawing respectively. The engine, although it has a designed output of 500 B.H.P. at 270 r.p.m., has been constructed to deal with an output of 575 B.H.P. at 300 r.p.m. Two motors are provided but only one of them will be required at any one time, depending on the direction in which the ferry is proceeding. All controls will be worked from the bridge on a special system developed by the British Thomson-Houston Company, Ltd., of Rugby. The new ferry, while retaining the main features of the steamers now in service, possesses many advantages, and, if successful, as no doubt it will be, it seems likely that oil-electric propulsion will be employed for replace ships.



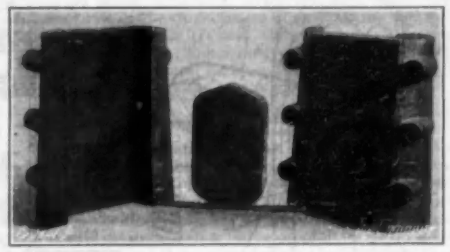

OIL-ELECTRIC FERRY BOAT

joints corresponding with the point of contact between tires and drum, and are prevented from rotating about the joints by an arm engaging with one of the axle casings. The shafts of the drums are connected to Froude hydraulic brakes, the casings of which are constructed in one piece with the swinging cradles.

After anchoring the vehicle in position the engine is started up, driving the rear wheels and thereby rotating the drums at a speed which can be regulated by adjusting a hand wheel controlling the resistance of the Froude brakes. Under the influence of the tractive effort exerted by the wheels of the vehicle, the swinging cradle pulls, through its pivotal joint, upon a weighing machine which indicates directly, without calculation, the B.H.P. developed at the axles of the vehicle. The internal con-

## Nicrosilal Heat-Resisting Castings.

THE engraving illustrating this short note shows a complete set of Nicrosilal ingot mould castings produced by the Sheepbridge Stokes Centrifugal Castings Company, Ltd., for use in the manufacture of aluminium ingots. The total weight of the complete mould casting was 14¼ cwt., and the weight of a single half mould 6 cwt. This is claimed to be the biggest Nicrosilal casting yet produced. The ingot mould halves were cast vertically in dry sand moulds, the metal being introduced by a long down runner and the casting fed from a large riser or sinking head. By this method a sound casting of excellent finish was obtained. Nicrosilal, it will be remembered, is the heat-resisting austenitic cast iron developed and patented by the British Cast Iron Research Association (British patent No. 378,508). It contains about 18 per cent. nickel, 6 per cent. silicon, 2 per cent. chromium, 1·8 per cent. total carbon, and 1 per cent. manganese, and is exceptionally resistant to growth and scaling and remarkably ductile. In consequence, it is not liable to cracking on sudden heating and cooling. Nicrosilal is



NICROSILAL INGOT MOULD

easily machinable, giving a fine surface finish, and can be burnished and surface hardened by cold work. It is non-magnetic, has an electrical resistivity of about 160 microhms per cubic centimetre, and has good corrosion-resisting properties under many conditions of weak acid mixtures. Nicrosilal is manufactured under licence from the British Cast Iron Research Association by the Sheepbridge Stokes Centrifugal Castings Company, Ltd., in its general alloy cast iron foundries.

## An Omnibus Testing Machine.

THE machine which we illustrate by the half-tone and line drawings on the next page has been designed and manufactured by Heenan and Froude, of Worcester, for testing the general performance of large motor omnibuses, with either four or six wheels, and is capable of taking vehicles up to a maximum weight of 12 tons. The machine is designed for mounting in excavated foundations, and is fitted with duplicate power drums lyng parallel with each other and having means for varying their centres to suit the twin driving wheels of the vehicle, which, when in the testing position, are anchored directly over and are supported by the drums. The drum shafts are carried in swinging cradles, which are pivoted at

struction of the hydraulic brakes is very similar to that used on standard Froude dynamometers. A pair of plates, the position of which is controlled by an external hand wheel, is interposed between the rotors and each brake casing. When the plates are fully withdrawn rotation of the shafts is strongly resisted by the hydraulic interaction between the rotors and casings, and the power required to drive the rotors at a given speed is a maximum. When moved progressively radially towards the shaft these plates cut off communication between the rotors and the casings, and gradually reduce the power consumption to a minimum. In this way the power consumed by the hydraulic brakes can be varied within very wide limits, and the speed of the drums on which the wheels of the vehicle are supported can be regulated so as to reproduce conditions of running at high speed on level roads, and also of climbing test hills at lower speeds.

The face of the horse-power dial gives direct readings of B.H.P. at various speeds between 10 and 60 m.p.h. Every alternative ring of figures consists of black graduations on a groundwork of white having a distinguishing colour line to improve legibility. When testing at any one of the speeds marked on the dial, the B.H.P. is indicated directly without calculation. For intermediate speeds the B.H.P. can be calculated by a simple formula.

Tuning up operations on the carburetter are greatly facilitated by the use of a flowmeter, which is mounted upon a column at the side of the omnibus tester, and receives a supply of fuel from a small overhead tank. The flowmeter feeds the carburetter through a flexible tube, the petrol piping of the vehicle being temporarily disengaged. The flowmeter gives instantaneous readings of the rate of petrol supply in miles per gallon corresponding with the speed at which the test is being carried out. In tuning up the carburetter while running, the effect of every adjustment is indicated instantaneously upon the B.H.P. dial and the scale of the flowmeter. The setting corresponding with maximum efficiency is thus arrived at in a minimum of time.

A positively driven speedometer is mounted at the side of the horse-power dial, where it can be conveniently read. It indicates, in miles per hour, the peripheral velocity of the drums, which is, of course, equivalent to the speed of the vehicle under corresponding road conditions. In conducting a test the accelerator pedal is held open, the hand wheel of the brakes is adjusted to give the desired road speed, and the tester automatically and instantaneously indicates both the B.H.P. and fuel consumption.

The brake testers—see line drawing—consist of six fluted rollers, each arranged to underlie and support one wheel of the vehicle. Four such rollers are mounted on the underframe, which carries the main drums. A further set of two brake-testing rollers and gear is carried upon a trolley which underlies and supports the weight of the front wheels of the vehicle. The rollers A are carried by ball bearings upon a shaft B, at each end of which crank webs C, Z are formed. The pivots D of the cranks C are carried on ball bearings in the upper end of compensating links E, which are pivoted upon the underframe. The axis of the rollers is extended to engage with radius links G, permitting the rollers freedom of motion in an approximately vertical, but not a horizontal, direction. These radius links are carried upon pivots H, which are attached to the underframe by blocks J. The weight of the roller assembly and links is balanced by a spring K.

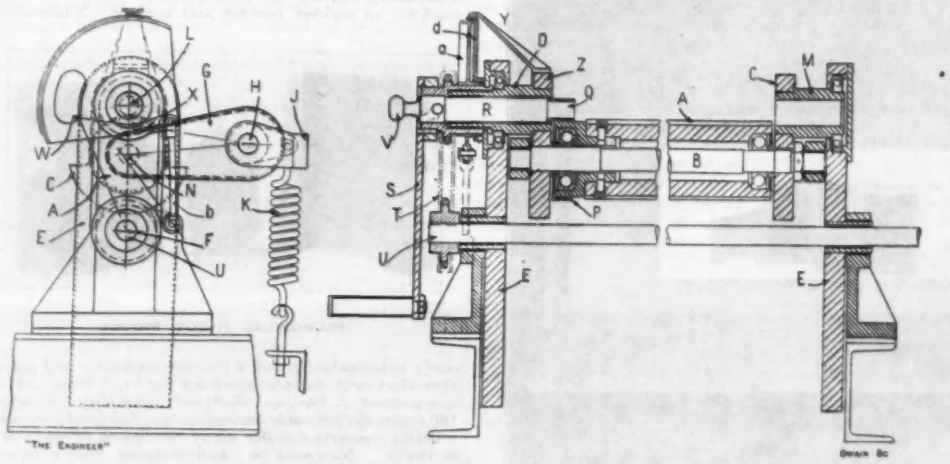
When the brakes of the vehicles are free and the wheel is resting upon the fluted rollers, the centres L of the crank pivots D, M, the fluted roller N, and the compensating link F, lie on the vertical centre line. In this position the weight of the vehicle has no turning moment about point L.

Keyed to the roller A is a gear wheel P, which meshes with a pinion Q, the axis of which coincides with that of the pivot D of the outer crank web. The spindle R of the pinion Q is shown extended to engage with a hand lever S, by which power can be applied to the fluted roller; but actually this hand lever is replaced in this model by an electric motor drive. Power is transmitted simultaneously by chain gearing T through the countershaft U to the second brake tester unit underlying the other wheel of the same axle of the vehicle.

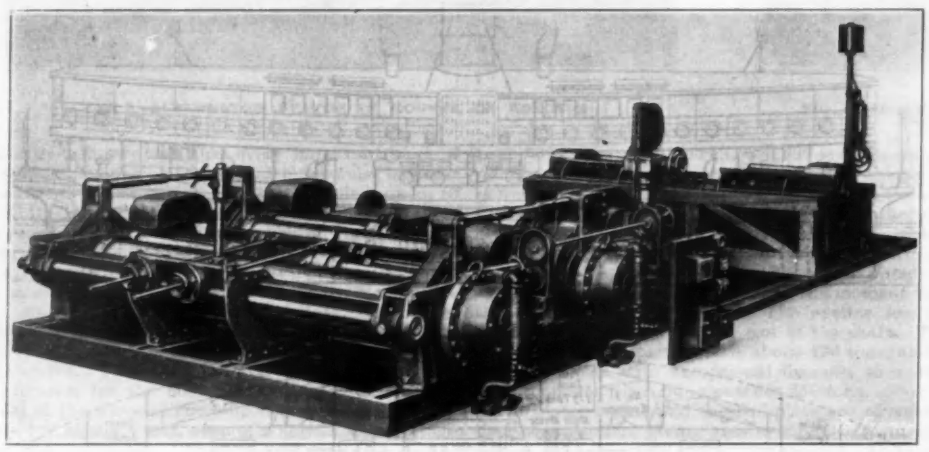
When the brakes are under test they are applied by means of a pedal depressor having an indicator to show the pressure exerted upon the brake pedal. The roller A is then caused to rotate, which, in turn, revolves the wheel of the vehicle. In transmitting the power necessary to overcome brake resistance, the gearing P and Q imparts to the crank Z a reactionary twisting moment, which tends to swing the pivot L away from the vertical until a point, such as W, is reached, at which the turning moment upon the crank is balanced by the fluted roller A acting at a horizontal distance from the vertical. At this point L has moved to W, and N to X, causing the crank centres to line on the lie W X, which, with the vertical centre line, makes an angle. In this position the weight supported by the roller A has a turning moment about W, which balances the torque reaction upon the crank Z, and the crank centres remain along W X, even while the roller continues to be rotated.

The angle L X W shows the relation between the retarding force exerted by the brake and that portion of the weight of the vehicle which is supported by the roller. This angle is measured by a pointer Y attached to the crank Z, and moving over the rim of a dial *a* mounted upon pivot D and prevented from rotating by the link *b*. The pointer carries with it a tell-tale pointer *d*, which remains in the position of maximum brake efficiency at the conclusion of each test. The rim of the dial *a* gives direct readings of the brake efficiency (per cent.).

It is obvious that the retarding force exerted by the brakes of the vehicle ought to be proportionate to the weight of the vehicle. Methods of estimating brake efficiency by measuring the retarding force alone do not give any adequate indication of brake efficiency without taking into account the weight that is supported by each road wheel. In many cases no convenient means exist for measuring the weight and the manner in which it is distributed. In the H.F. omnibus tester the weight of the vehicle is balanced against the forces arising from the retarding effect of the brakes, and these are resolved into a single reading of brake efficiency which requires no knowledge of the weight of the vehicle, or its distribution over the four or six wheels.



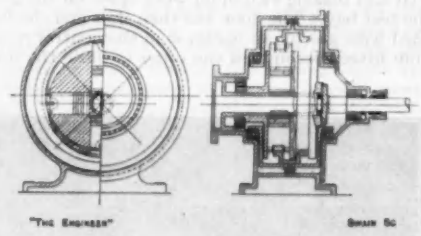

BRAKE TESTER OF OMNIBUS TESTING MACHINE



OMNIBUS TESTING MACHINE

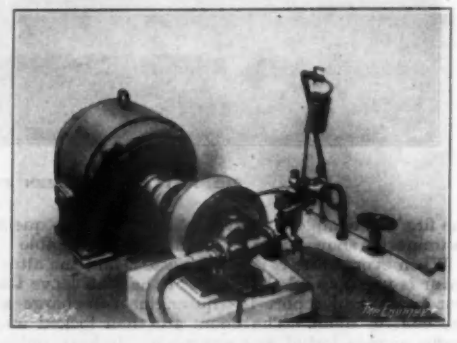
## The Anderson Rotary Steam Engine.

THE accompanying illustrations show a new rotary steam engine produced by John H. Wilson and Co. (1929), Ltd., of Birkenhead. The engine, which is made in a range of sizes from 1½ to 150 B.H.P., is compact in design and light in weight, and may be mounted either vertically or horizontally. One of the engravings shows it driving an electric generator. The cylinders are mounted radially about a common axis, may be four or eight in number,



ROTARY STEAM ENGINE

and are free to rotate about the axis. They are encircled by a steel reaction ring able to rotate about its axis and mounted excentrically in relation to the cylinders. This ring takes the thrust of the pistons and rotates in the same direction as, and at approximately the same speed as, the cylinders. From the line engraving it will be seen that the cylinder casting rotates on roller and ball bearings, and is flanged at one side to take the flange of the driving shaft. The cast iron pistons carry at their outer ends shoes which bear against the reaction ring. These shoes



ROTARY ENGINE AND DYNAMO

are so shaped as to prevent turning of the pistons within the cylinders. Perhaps the most interesting point of the design is that the reaction ring is so mounted upon a plate as to be able to rotate, as will be seen from the drawing. Steam is admitted and exhausted from the cylinders through a stationary cast iron trunnion arranged concentrically with the cylinder casting. It is centred in the casing at one end and supported by a ball bearing at the other.

## Provincial Letters.

### THE MIDLANDS AND STAFFORDSHIRE.

*(From our own Correspondent.)*

**The Year Ends.**

THERE will be few industrialists in the Midlands and Staffordshire who will mourn the passing of the year 1932. Fortunately, however, recent developments in trade lead to hopes of better times ahead, so that there is a welcome for the year 1933. Taken as a whole, the past twelve months have been fairly disastrous for those in industrial trade circles, for they have witnessed a decline in demand for iron and steel, and for engineering products and manufactured goods, a fall in outputs and profits and no compensating reduction—indeed, the reverse—in overheads and production costs generally. For manufacturers of all classes it has been a most trying time, and one which it is hoped will not re-occur. For the past month or so there has been some improvement in demand in certain quarters, and prospects of future trade have become brighter. During December and at the latter end of November a number of local industries received better orders, and plant has been working with greater regularity than during many months of the year. Nevertheless, there has only been engaged a skeleton of the staff formerly employed about the works and offices, but as work increases the numbers are slowly added to. Now, at the close of the year, there is no great carry-over of orders, but there are held to be prospects of substantially improved business when the New Year sets in and manufacturers are looking hopefully to more numerous and larger orders and contracts than fell to their lot during the past twelve months. Producers of iron and steel in this area, while they booked little or no business for this week, have received inquiries as to supplies for the first few weeks in 1933, and in some cases quite substantial orders have been placed on which deliveries are to commence on January 1st. There is a tendency towards buying further forward than has been the case for many months past, and, given freedom from upheaval and further trade restriction, it is trusted definite progress towards recovery will be experienced during the first quarter of the New Year. The improvement which showed itself in trade a few weeks ago is

expected to reassert itself, and industrialists, heartily glad to see the back of the year 1932, welcome the New Year with renewed hope and some confidence. The past twelve months, or the greater portion of them at any rate, have been so distinctly bad from a trading point of view that producers and manufacturers in the Midlands and Staffordshire are thankful indeed that they have been able to keep in production. It has only been by drastic economies, reorganisation, and dozens of other moves that many have been able to weather the gales of the year. They are embarking upon a fresh voyage on the seas of 1933 with characteristic British pluck and endurance, and they pray for fair weather, large shoals and heavy catches to compensate them to some extent for the unsatisfactory character of the past year's hauls and profits.

### Steel.

Makers of finished steel hold no brief for the year 1932, and they do not wish to retard its demise, yet they cannot look to its successor with any degree of comfort. The structural and general heavy engineering industries and the rolling stock establishments have, during the past twelve months, been but poor supporters of the steelmasters. Not that it has been their fault. In the Midlands the majority of users have stood firmly by the British steelmaster, giving him all the business they possibly could; but they have been so short of work themselves that their requirements were small indeed. Steelmasters, for their part, have kept selling prices at a steady level, and have maintained the preferential terms granted to those who declined to use any foreign steel. What the New Year will bring in the way of big-scale constructional work requiring large tonnages of steel is a mystery. The country and the world at large are in too disturbed a financial state to justify anyone even hazarding a guess at the probable trend of events and the consequent chances of trade improvement in the finished steel branch of Midland industry. In the half-products branch things are much brighter. The bulk of the current year has resulted in poor business, but towards the close there has been a gradual progressive movement, brought about mainly by the decline in foreign competition, and, what is still more cheerful, the outlook is promising. At date there are some qualms as to the underlying motive that has brought about a fall over the past fortnight in prices of some descriptions of French and Belgian semis. Re-rollers especially in this area and producers of billets are watching the movement with interest, and in this they are accompanied by manufacturers who consume at their works bars and billets. British producers are now getting more of the business which is in circulation, but the large amount of foreign material brought in earlier has not yet been entirely used up. Stocks are gradually sinking, however, and the home trade, given a continuance of present trading conditions, ought to experience a greater impetus early in the New Year. The changed attitude of Continental competitors at the year's end, however, leads to fears of a revival of fierce foreign competition for the British market in 1933. At the moment the movement is rather mystifying, as there has been an undoubted tendency of late towards eliminating price-cutting and it can hardly be realised that producers there have so quickly changed their opinion. As the year closes, steelmasters adhere to the selling prices which, in the controlled branch, show no alteration on the year. Angles are still quoted £8 7s. 6d., tees £9 7s. 6d., joists £8 15s., and ship, bridge and tank plates £8 17s. 6d. Boiler plates, which in January were £8 12s. 6d., are now £8 7s. 6d. to £8 10s. In the half-products branches, however, there have been greater alterations, all-British small bars, which at the opening of the year were £7 15s. to £8, are now £7, while small re-rolled bars, which were £6 17s. 6d. to £7, are now £6 15s. Staffordshire hoops are unchanged at £9 10s.

### Pig Iron.

Midland blast-furnacemen have had to curtail production during 1932. Nevertheless, they have accumulated heavy stocks in their yards, consumptive requirements having proved to be below smelters' expectations, and therefore less than pig iron output. At several periods of the year there have been buying spurts, but they have not been long sustained. On the whole, however, perhaps smelters have not so much to complain of as producers of other materials. Certainly they have not been so hardly hit as the manufacturers of finished steel. They have, moreover, been reasonably free from competition. The cost of transport inland makes foreign pig too dear to commend itself to Midland foundrymen. The chief trouble in the pig iron industry has been the very poor demand experienced from the engineering foundries. These have been very poorly engaged throughout the year and their consumption of raw material has been only a fraction of what it normally is. The light castings trade has stood the blast-furnacemen in good stead and has kept up a continuous call for material. Sales of forge grade iron have been small. The Staffordshire forges have had little work, and at date they are in a bad way. Smelters are not looking for much assistance from this direction in the immediate future. Derbyshire blast-furnacemen have, during the year, had the assistance of their associated pipe foundries, who have taken the bulk of their production. Northamptonshire ironmasters, not having the same measure of support, have had to seek outlets for their production in other markets, and they have met with no little success in the North. They have sold there, however, at a lower price than they would have obtained in the Midland area, so that the business has not been so profitable. The Central Pig Iron Producers' Association has had the loyal support of all makers in this area throughout the year and quotations have been definitely as fixed by the price control body. In Birmingham at date the selling prices of Midland brands of iron are exactly as they were twelve months ago. Derbyshire and North Staffordshire are based on £3 6s. for No. 3 foundry and £3 1s. for forge, and Northamptonshire £3 2s. 6d. for foundry and £2 17s. 6d. for forge. At the time of going to press these prices are due for revision at the monthly meeting of the Association, and while there is said to be some possibility of an increase, the general opinion appears to be against interference with the existing rates at the moment.

### Staffordshire Bar Iron.

There has been little or no regularity at the Staffordshire finished iron mills during the past year, and while there are but few tangible evidences of a probable extension of demand in the early part of the coming year, ironmasters contend that business can hardly be worse. They are accordingly turning their faces to the bright side, hoping for better trade in all departments. For the past twelve months they have carried on without any real reserve of orders. It has been difficult and at times impossible to arrange rolling programmes more than a week ahead. Orders have come in day by day, but they have been for small tonnages. Large numbers of ironworkers have had to be dismissed, and for a large part of the period under review the remaining employees have been occupied only about 50 per cent. of the normal working week. Efforts have been made in some branches of the trade to stimulate demand by reducing prices, but they have met with practically no response. Crown bars, which at the end of last year were selling at £9 5s. minimum, have declined fully 5s. per ton. The selling price of nut and bolt iron is down on the year by 7s. 6d. per ton; fencing bars, which were £8 7s. 6d., are now £7 18s. Iron tube strip prices have fluctuated and at date stand half-a-crown per ton below the selling level in December last. Producers of marked bars have adhered throughout the year to their quotation of £12 per ton. They claimed that this was the lowest economic rate and, failing any evidence that output could be increased as a result of better buying if prices were lowered, they declined to make reductions. Taken on the whole, the marked bar mills and the strip mills have had a better year than those devoted to the production of other grades of finished iron, and the outlook for them is even now more promising than it is for the crown and common bar departments.

### Galvanised Sheets.

The galvanised sheet trade in this district has experienced many ups and downs during the year. At times business has been fairly brisk, while at others output has been much restricted. Overseas consumers have been worried considerably by the fluctuations of sterling, while financial stringency the world over has been one of the other numerous additional restrictions to free buying. A number of overseas markets are, as the year ends, showing a disposition to make fairly large purchases, and there are signs of awakening interest in other directions. Fortunately for the local mills, the home trade has kept up well during the whole time and has provided something of a standby for the industry. In the latter half of the year combined action over prices was taken by makers. A scale of selling rates for the home trade was agreed upon, while those for export were fixed at a firm level. This was brought about by the "cutting" tactics of a number of firms which brought prices to an unremunerative level. Buyers at home were not pleased with the alteration, but they have now settled down to it and business continues unrestricted by animosity. Selling prices are higher than they were twelve months ago. Just prior to Christmas sheet makers raised their prices further, giving as an explanation the recent appreciation of spelter values. The market was certainly surprised by this further move, especially as the advance in the case of galvanised sheets amounted to 10s. per ton and in the case of black sheets 5s. per ton. In December last the quotation for 24-gauge galvanised corrugated sheets for export stood at £9 5s. per ton f.o.b. To-day the fixed price is £10 10s. per ton. Home prices, which are now quoted delivered, start at £11 15s. for 24-gauge and advance on a graduated scale according to tonnage. Black sheets were also brought into the scheme and these at date are named £8 10s. for export and £9 10s. upwards for home trade. Mill owners express a certain amount of confidence in the New Year, which should, at any rate, bring them remunerative business in place of the profitless orders of the early part of 1932.

## LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER.

### Overseas Trade in Textile Machinery.

FROM the point of view of export business in textile machinery, British manufacturers are likely to have a substantial margin in hand, compared with a year ago, when the full returns are available for 1932, in spite of the fact that the promise held out by the shipments in the earlier months has not been maintained. Exports in November totalled 4945 tons, valued at £422,612, compared with 5414 tons and £458,662 in the corresponding month of the previous year. Last month's shipments included 3296 tons of spinning and twisting machinery, valued at £285,241, and 1239 tons of weaving machinery, valued at £82,098. In spite of the fact that exports to several markets were appreciably better than they were in November of last year, the improvement in this respect was not sufficient to offset the declines in other directions. The German takings were on a larger scale, as were also those of South American countries and Australia. Exports to British India reached a value of £160,031, China occupying second place with £38,245, followed by South America £28,578, Germany £21,465, France £16,611, Japan £15,638, Australia £14,053, the Netherlands £12,553, the United States £8611, and Russia only £708. Shipments to "other European countries" reached an aggregate value of £76,987.

### Major Factors.

Exports of textile machinery for the January-November period amounted to 57,428 tons, valued at £5,010,958, compared with 49,777 tons and £4,785,434 in the corresponding eleven months of last year, so that, as already stated, a balance in favour of 1932 at the year-end is virtually certain. Major restrictive influences on textile machinery business have been the difficulties of trading with Russia, which have resulted in a contraction of exports to that country during the eleven months to £80,480, compared with £144,880 in 1931, and £743,264 in the first eleven months of 1930, and the raising of the tariff wall in France, shipments thence reaching a value of only £165,031, against £405,500 in the previous year, and £721,581 in 1930. On the other hand, the easing of the boycott situation in India has resulted in an expansion of exports from £1,561,692 a year ago to £1,753,238 this year, the latter figure comparing with £2,364,548 in the January-November period of 1930. Other markets to register varying degrees of improvement on the eleven months are the Netherlands, China, Japan, South America and Australia.

### Engineering Trade with India.

In discussing prospects of Lancashire trade with India at a luncheon in Manchester, Sir Thomas Ainscough, the Senior British Trade Commissioner in India and Ceylon, dealt with the position of the textile machinery, electrical, locomotive, and machine-tool branches of the engineering industries, in which, he said, Lancashire firms had such a vital interest in India. The industries in question were maintaining their relative position in the Indian market, but were suffering from the curtailment of Indian Government purchases on account of financial stringency and the depression of most Indian industries. As soon as world conditions improved and there was a permanent rise in the world prices of agricultural products, we should find, said Sir Thomas, that India would respond almost immediately. The country merely waited for a world revival in prices and confidence to resume her steady advance among the world's trading nations.

### Order Book Additions.

The important extensions to plant at Bowater's Mersey Paper Mills, Ltd., Ellesmere Port, Cheshire, have resulted in substantial orders being placed with Lancashire engineering firms. Charles Walmsley and Co., Ltd., Bury, have secured an order for papermaking machinery which is said to approach a value of £250,000, and a contract for cranes has been placed with the Vaughan Crane Company, Ltd., Openshaw, Manchester.

### Non-ferrous Metals.

With the market closed for the greater part of the week, and with the added influence of the approaching holiday, business in the non-ferrous metals generally has been on a much reduced scale. In the early days copper registered a fairly substantial advance, but a certain amount of reaction occurred later. However, at the close the metal seemed to be reasonably steady. Some improvement in the position of the Welsh tin-plate industry is a factor in the tin section, and here also for the present values are being fairly well maintained. Buying interest during the past week has, however, been slow, and the turnover in the metal has been poor. Considering the holiday conditions, a moderate demand for lead has been experienced, and not much in the way of price movement has occurred. Only a relatively quiet business has passed in spelter, but firmness continues to characterise the price position in this section.

### Iron and Steel.

Business in the iron and steel markets here has been virtually at a standstill, and little movement in any of the materials, apart from deliveries against orders already held, is looked for until towards the middle of next month. Values of imported products tend to ease, but in all other respects quotations are steady. As the year closes the market seems to be disposed to regard future prospects a little more cheerfully. This feeling is based partly on the fairly substantial orders booked by Lancashire engineering firms in one or two of the specialised branches, and partly on reports of a better volume of inquiry being dealt with by some general engineering concerns. Seasonal optimism is undoubtedly also a contributory factor.

BARROW-IN-FURNESS.

### Hematites.

Business in hematite pig iron always eases down during the holiday period. Inquiries have been fuller of late and smelters of iron are looking for an increase of trade in the New Year. Iron production is at a low level, far from the normal, but at present it is sufficient to meet all wants, plus the stores of iron held. A material reduction has been going on in these stocks. A satisfactory feature of the present position is the fact that there is a steady outlet of iron to local steel makers.

### Iron Ore.

The demand for iron is of necessity quiet. There is a big tonnage of ore stored on the banks at the pits. A little more Spanish ore has been coming in lately.

### Steel.

The holidays are being observed in the steel-making centres over the two week-ends. Generally the demand for steel rails is quiet, but orders are in hand to keep the plant going for a time at all events. Hoops, steel strips, and flat sections are meeting a steady demand. There is a fair demand for castings.

### Shipbuilding and Engineering.

Vickers-Armstrongs, Ltd., are to build a training ship for the Brazilian Government, and there are prospects of new work in the spring. At present these trades are moderately employed.

## SHEFFIELD.

*(From our own Correspondent.)*

### Year-end Optimism.

THE amount of work done in Sheffield since Christmas has been much below the normal, as many of the firms, at any rate so far as the heavy branches of industry are concerned, set down for a full week, though resumption depended on the quantity of new business coming forward this week. The year ends with a fair

amount of optimism in trading circles, where an early improvement in business is looked for. It was cheering to know that the output of steel ingots and castings in November was the highest since February, and that in the finished steel departments the approach of the holiday necessitated a speeding up of production in order to fulfil orders on hand. The last two or three months have shown distinct progress in both orders and inquiries received by several departments. The present position, taken generally, is certainly better than that of a year ago, although work is still unevenly distributed, and slackness is to be found in many cases. There has recently been a recovery in the demand for steels of best quality. It is believed that a much more substantial revival would have been seen if it had not been for several adverse influences which have hindered the upward movement, these including the War Debt controversy, the Salter Report, and the loss of most of our trade with the Irish Free State.

### Better Prices Wanted.

There is a good deal of unremunerative working in Sheffield, owing to the prices of steel and steel material, which continue low and steady. There is much keenness of competition and cutting of prices, owing to efforts to provide occupation for men and plants. Following upon a drastic economy campaign, steel makers will begin the New Year with costs lower than at any time since the war. Mr. T. Nightingale, managing director of Sheffield Steel Products, at the annual meeting of the company, spoke strongly on the question of prices. Competition in times of bad trade, he said, had given birth to intensive price-cutting, developed to a destructive extent. In many spheres manufacturers had ruined the position from within, and one of the problems of the immediate future of interest to Sheffield was how to get back to prices which would yield a really decent profit.

### Government Orders.

Several local firms will benefit from the latest series of contracts placed by various Government Departments. The Admiralty has ordered carbon steel and drill sockets from the Sheffield Twist Drill and Steel Company and William Brookes and Sons, Sheffield; and steel ship plates from the Park Gate Iron and Steel Company. The War Office is taking steel bars from the Park Gate Company, steel billets from Hadfields, Ltd., mild and medium tensile steel from Thos. Firth and John Brown, Ltd., Sheffield; and also a bore-hole pump from Worthington-Simpson, Ltd., Newark. Towing cable for targets, required by the Air Ministry, is being obtained from John Shaw, Ltd., Sheffield; and John Baker and Bessemer, Ltd., of Rotherham, are to manufacture steel tires for the Crown Agents for the Colonies.

### Colliery Matters.

At the Ireland Colliery of the Staveley Coal and Iron Company, Ltd., advantage is being taken of the holiday period to effect a change-over from old to new screening plant. The new screens have been erected by Messrs. Plowrights, of Chesterfield. They will facilitate increased efficiency in the handling and sizing of coal, and are designed to meet present and future market demands. A couple of good local colliery records have been made lately. At Maltby Main Colliery, during the week ending December 16th, the output was 21,900 tons, the highest ever recorded in the pit's history. At Silverwood, not far away, the amount raised during the week ended December 21st was no less than 28,280 tons. It was all raised out of the West Pit shaft, and is thought to be a world's record for a weekly tonnage drawn out of one shaft. The previous best from this shaft was 25,709 tons, for the week ending January 13th, 1932. During one shift of the recent week the tonnage brought to the surface was 4566 tons, which created a new record.

### Trade with Scandinavia.

Although the detailed report of the British trade delegation which recently visited Denmark, Sweden, and Norway is not yet available, there is good ground for anticipating that the results of the mission will be favourable. Mr. F. C. Fairholme, who headed the iron and steel section as a representative of the Sheffield Chamber of Commerce, has addressed a meeting of the Sheffield Industries Overseas Trade Committee, and hinted at prospects of beneficial results to Sheffield trade. He said that, generally speaking, the deputation received a cordial welcome, and every facility was given them for informing themselves as to the local position, and the possibilities of increasing the British share of iron and steel imports into the Scandinavian markets. He expressed the view that in some instances the position is not unsatisfactory.

### Hull Water and Omnibuses.

Hull Corporation's great scheme of waterworks extension has been sanctioned by a town's meeting, which approved of the promotion of the necessary parliamentary Bill. There was some opposition on the ground that the great Farndale scheme is not necessary, and that the present pumping stations have sufficient capacity, but the vote in favour of the Bill was carried by a large majority. The estimated cost of the construction of the reservoir at Farndale, with pipe line to Hull, is £1,137,000. The Chairman of the Water Committee said the capacity of the reservoir would be 6000 million gallons, and the length of pipe 46¾ miles. The site could be developed as the water demand increased, and they would have a supply which would be adequate to meet all demands during the next 100 or 150 years. They would get the water to the reservoir at Keldgate, near Hull, at a cost of something like 3¼d. per 1000 gallons, and the whole scheme could be developed without any increase of the present water charges or any charge on the rates of the city. Another great scheme now before Hull is one which has been approved by the City Council for building a central station for all omnibuses, a garage, and workshop for municipal omnibuses, in a new thoroughfare in the centre of the city. The cost will be £111,000, and the construction work will provide employment for 1200 men.

### A Gigantic Anvil.

One of the recent massive achievements of Sheffield has been the production of one of the largest anvils ever made. It is a block of cast iron weighing 85 tons, and has been made by the Brightside Foundry and Engineering Company. It is approximately 7ft. high and its other measurements are 9ft. 3in. by 8ft. 3in. It is for use with a drop stamp and is being supplied to Smith's Clayton Forge, Ltd. It made the journey from Sheffield to Lincoln by L.N.E.R. on a 110-ton trolley wagon. As it exceeded the width of the single track, special arrangements had to be made by the railway company to clear the adjoining lines during its transport.

### A Water Grid Proposal.

The interesting question of a water grid scheme is being discussed in Bradford, a city which is in the fortunate position of having large water reserves, and which has been asked if it can afford a supply to other places. The recent outbreak of typhoid fever in the Malton district has led to one of these inquiries, relating to a supply of 5,000,000 gallons per day to the East Riding, and there has also been an enquiry from Hull as to whether Bradford could supply that city with 10,000,000 gallons per day by means of a pipe line which Hull would construct. The Bradford Waterworks Engineer states that at present Bradford has 11,000,000 gallons running to waste every day, and it would be a great advantage to the city if they could be utilised. The Chairman of the Water Committee has outlined a possible grid scheme under which a pipe line, 27in. in diameter and 50 miles long, would be laid from the Nidd aqueduct to Garrowby Hill where a service reservoir would be constructed to hold 20,000,000 gallons. This would supply Malton, Driffield, Beverley, Market Weighton, Stamford Bridge, and numerous villages. The pipe line would be continued to a small service reservoir holding 2,000,000 gallons, to supply an agricultural district further on. The expenditure on such a scheme would be approximately £430,000, consisting of £355,000 for the pipe line, £65,000 for the larger reservoir, and £10,000 for the smaller one. The matter is, of course, in an early stage, and no definite scheme has been drawn up, but the question is being followed with much interest.

### Cutlery and Plate.

There is little change to report in the state of these trades, which have had a large proportion of holiday this week. The Christmas season demand was not up to the normal, and, in larger measure than usual, was for the cheaper classes of goods. In the spoon and fork department chromium-plated articles are being bought to an increasing extent instead of silver-plated. The enormous demand for safety razor blades is fully maintained, and it is calculated that Sheffield's production of these now runs to 4,000,000 per week. There is also great activity in the scissors department, in which Sheffield enterprise, assisted by Customs duties and exchange differences, has practically eliminated foreign competition. Thanks to extensions of plants, embodying the most modern ideas, Sheffield can now produce scissors more cheaply than ever before, and, besides holding a supreme position in the home market, is in a strong position to compete for overseas trade.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### Revival of Pig Iron Warrant Market.

CONSIDERABLE interest has been aroused in iron trade circles in the North of England by the movement in London to revive the pig iron warrant market and the proposed establishment of warrant stores in the chief iron-producing centres. It is of particular interest to those associated with the fortunes of the Cleveland pig iron trade, in which the warrant system was in operation for many years up to the war period. The system has its advantages as well as its disadvantages, and conversations I have had with both ironmasters and merchants reveal a marked divergence of opinion as to the advisability of its revival under the present abnormal conditions. Prior to the war it was the established practice in the Cleveland iron trade for the ironmasters to transfer their surplus output of pig iron into Connal's public store at Middlesbrough, obtaining in exchange warrants which were readily negotiable on the iron market. Speculative influences, of course, often caused sharp fluctuations in market values, but, generally, it could be said that the system was of benefit to the industry. On many occasions the iron stored proved a useful reserve upon which to draw in cases of emergency. At the time of the outbreak of war, for example, over 100,000 tons of pig iron were thus held in the store at Middlesbrough, and proved a valuable asset to the nation in period of emergency, Only three years previously the stock exceeded half a million tons, and in 1905 the tonnage reached a high-water mark of over 700,000 tons. During the war the stocks of iron in the public store were speedily exhausted, and in March, 1916, an Order in Council was issued prohibiting all speculative dealings in pig iron. This was the final *coup-de-grace*, and although tentative proposals have been put forward the warrant system has never since been revived. This, no doubt, has been largely due to the opposition of the ironmasters, who have discovered, in the absence of pig iron warrants, a means of exercising a more or less rigid control of prices. They have, however, been unable to avoid the accumulation of stocks of pig iron, which, it is understood, are largely pledged to the banks. It is held that there are ample reserves of stocks to form the basis of very extensive transactions, and it is claimed that a restoration of a free market in these warrants will restore flexibility to the price level and permit of much greater activity in the pig iron markets.

### Industrial Tonics.

It is encouraging to find at almost the end of a year of depressed conditions an optimistic vein running through the heavy engineering industry. This has been engendered not only by the increased number of inquiries, but the actual placing of orders. The Birtley Company, Ltd., formerly the Birtley Iron Company, Ltd., in particular, is entering the New Year with excellent prospects after just finishing a year of remarkable prosperity. During the past twelve months the firm has supplied sixteen of their large Birtley dry coaling installations, and only this week secured a contract for another at Dawdon Collieries, of the Londonderry Collieries, Ltd., this being the third for the same owners. Two other orders have also been secured, one from Czecho-Slovakia and the other from Holland. As in previous years, the orders have been for many parts of the world. Indeed, there is only one coalfield in which the Birtley process is not operating, and that is in South Africa, where the conditions do not lend themselves to it. There is even a small plant made by the firm in the Indian coalfield, and this year the first dry coal cleaning plant in Russia was completed and put into operation by the Birtley Company. Another important contract announced is that dealing with the construction of petroleum storage tanks to be erected at Haifa, Palestine, which is to be shared equally between the Wheasoe Foundry and Engineering Company, Ltd., of Darlington, and the Motherwell Bridge and Engineering Company, Ltd. The value of the contract is about £160,000, and will entail the use of about 8000 tons of British steel. It is understood that as first deliveries against the contract are not required for some months, an immediate start is not to be made with the work at Darlington. Orders have been received by Ashmore, Benson, Pease and Co., Ltd., Stockton, for a coke and ore-conveying plant and a limestone and ore-crushing plant for a Midland firm, in which 1000 tons of steel will be used. The firm has also, among other orders, contracted to supply an ore transporter bridge crane, with a capacity of 200 tons per hour, for an iron and steel works in South Africa.

### Cleveland Iron Trade.

Much improved conditions are being enjoyed in the Cleveland pig iron trade. All the blast-furnaces were kept in full operation over the holidays, although deliveries to the consuming works have been largely suspended. There is a much more confident feeling abroad. Actual sales of Cleveland iron have been substantial for delivery over the first quarter of next year, and there are indications also of better export business, a foothold having been secured in markets which have been closed to Cleveland iron. Prices are unchanged. Special concessions are still offered in Scotland and for export trade, but home sales are only made at the fixed prices, viz.: No. 1 Cleveland foundry iron, 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d., and No. 4 forge, 57s.

### Hematite Pig Iron.

There is a much better tone in the East Coast hematite pig iron trade. Business is better than it has been for many months, and there is a feeling of greater confidence in the future. Prices show a firmer tendency, but it is still possible to purchase mixed numbers at 59s., and No. 1 quality at 59s. 6d.

### Ironmaking Materials.

Foreign ore consumers show little disposition to enter into extensive contracts, and business is chiefly confined to odd cargoes. Best Rubio ore is fully 15s. c.i.f. Tees, and merchants take the view that prices must advance still further. Good medium blast-furnace coke is quoted at from 15s. 9d. to 16s. 3d., delivered to North-East Coast works.

### Manufactured Iron and Steel.

Most of the steel works closed down for two days over the Christmas holidays, and will also cease operations for a similar period next week. The demand in most sections of the industry is expanding, and operations at the works are more active than for many months past. Foreign imports of semi-steel have ceased in this area, and there is an increasing home trade following the liquidation of stocks. Quotations are steady and firm.

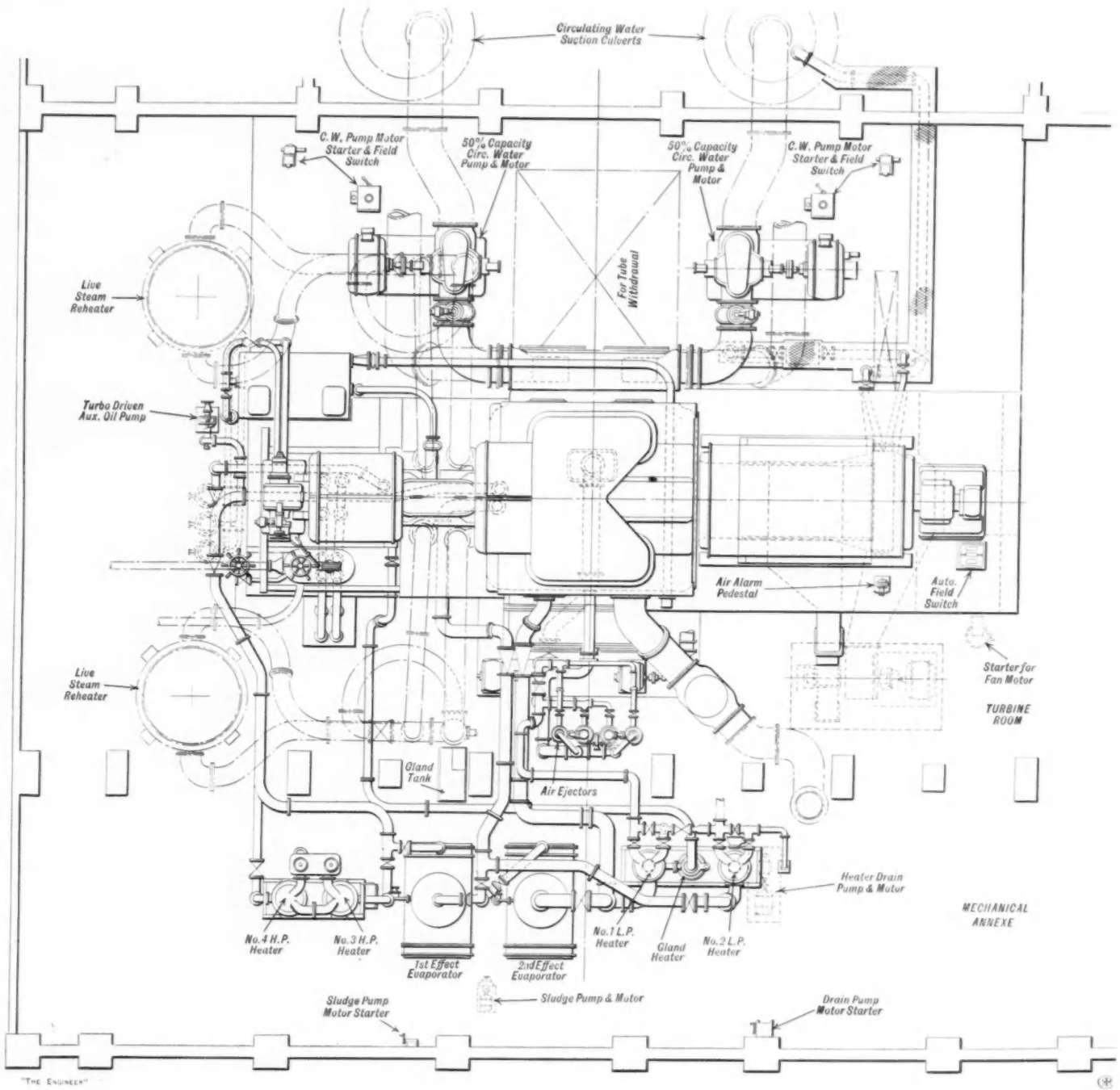
### The Coal Trade.

The Northern coal trade outlook continues bright. All brands of steam fuel are fully sold out up to maximum quota for this month, and are already booked for January deliveries. For prompt, loading turns are also well taken up by definitely stemmed tonnage, and any further business is difficult to place, odd lots becoming available from day to day realising maximum recent prices. The outlook for January output is encouraging, and under brisk inquiries prices are quoted steadily. Best Northumberland large steams are 14s. 6d., smalls 8s. 6d., Tyne prime large 13s. 6d., smalls 9s., and other qualities 12s. 6d., and smalls 8s. All these brands of small coal are scarce owing to the bulk of the output being cleared as washed or dry-cleaned coal. The Durham gas coal position is very steady, bookings absorbing all current output. Inquiry is active well into January, giving hope that recent working conditions at the collieries will be fully maintained. Best qualities are very steady in tone at 14s. 6d., and special Wear qualities at 15s. The bunker trade maintains its recent activity, all the favourite descriptions finding a quick sale at 14s. 6d., and for good seconds 13s. 3d. to 13s. 6d. is freely offered. Durham coking unscreened is a quiet section at from 12s. 6d. to 13s. 3d., according to individual brands. There is a brisk inquiry for coke nuts, but makers can readily increase output, and prices, while firm in tone, are unchanged at 17s. to 18s. Gas coke is in demand, but only odd lots are available at a firm 18s. 6d. Patent oven coke demands are maintained, and the tone is fully steady at 15s. 6d., with superior brands at 16s. 6d.

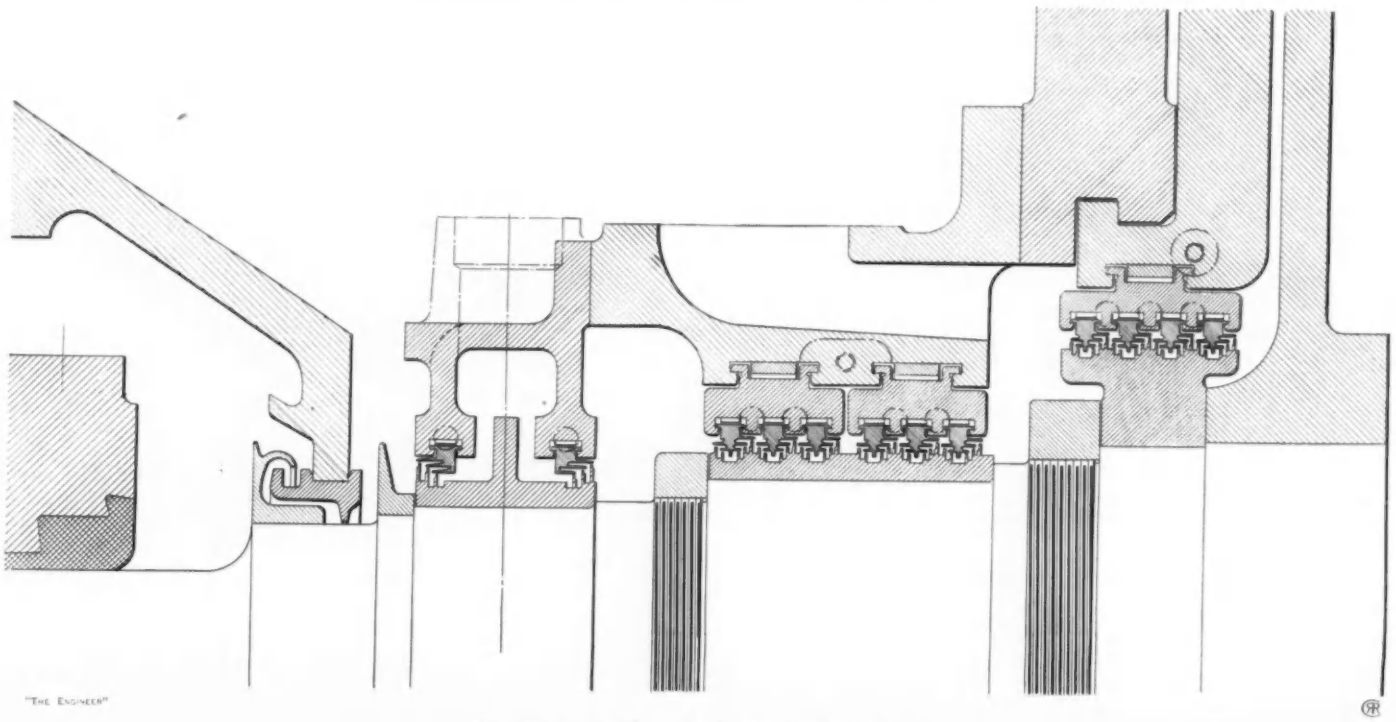
UNIV. OF WICH.

# SANYO CHUO HYDRO-ELECTRIC COMPANY SH

METROPOLITAN - VICKERS ELECTRICAL OMPANY



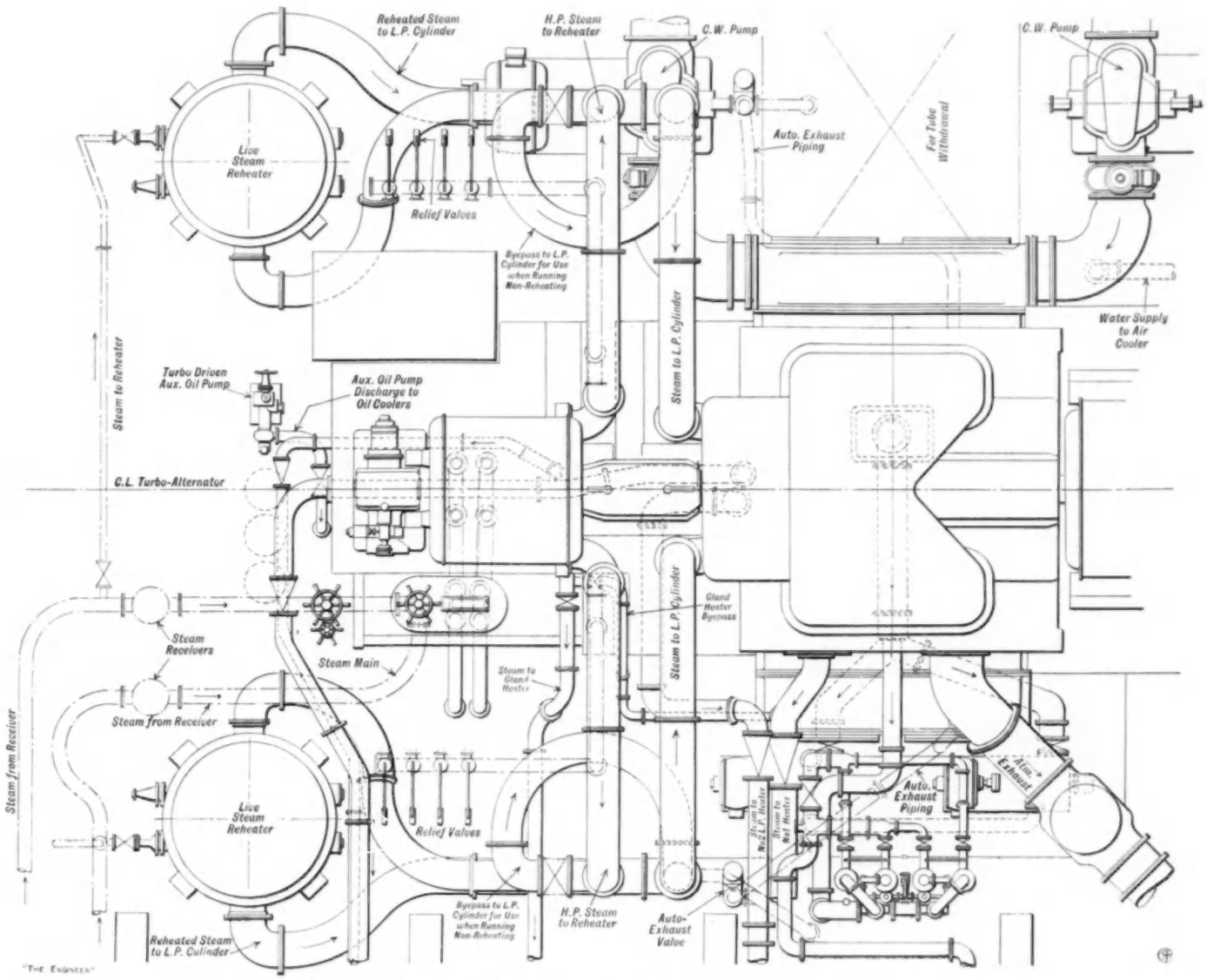

PLAN OF TURBO-ALTERNATOR SET AND CONDENSING PLANT



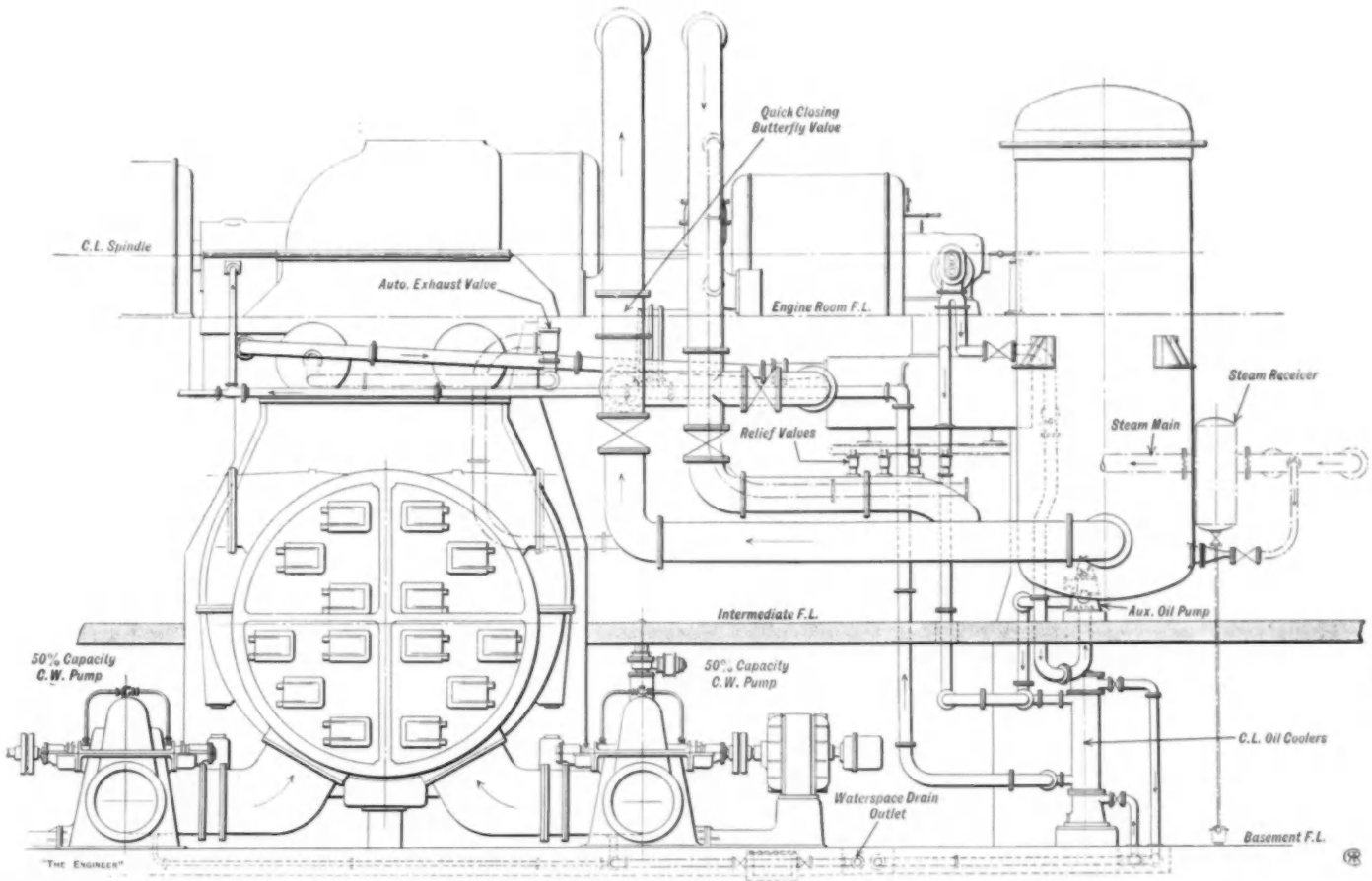

LOW-PRESSURE SPINDLE GLAND AT INLET END

# NY SHIKAMA, JAPAN—STEAM TURBINE PLANT

CAL MPANY, LTD., MANCHESTER, ENGINEERS




PART GENERAL ARRANGEMENT PLAN OF TURBO-GENERATOR SET




GENERAL ARRANGEMENT OF SET AND CONDENSING PLANT

UNIV. OF MICH.

## SCOTLAND.

*(From our own Correspondent.)*

### The Holiday Season.

BUSINESS in steel, iron and coal has been tapering off for some days now, owing to the Christmas holidays and the end of the year. Markets as a rule have been almost devoid of fresh feature, but although the outlook may still be termed obscure, there is apparently more confidence that the turn of the year will witness an improvement in trade sufficient to justify the modest degree of optimism which has been expressed within recent weeks.

### Steel.

As the year closes business continues on lines well defined for some time past. Specifications for plates and sections represent a most modest tonnage. The demand for shipbuilding purposes shows little expansion to date, and structural requirements have not attained normal proportions. Production generally is still round about 40 per cent. of capacity.

### Steel Sheets.

The lighter gauges of black sheets still receive a fair amount of business, but the heavy descriptions have not yet responded. Galvanised flat and corrugated sheets, too, have only a very moderate turnover.

### Tubes.

Hot-rolled seamless tubes constitute the only satisfactory department in the tube industry at present. The general inquiry has been fair, but the amount of business transacted has been disproportionate.

### Iron.

Producers of bar iron are not any busier, either in "Crown" or other qualities, and re-rolled steel bars are in much the same position. The former is unchanged in price, and the latter still quoted £7 5s. home and £6 10s. per ton export.

### Pig Iron.

Home requirements in pig iron are still met from stocks and the output of the two furnaces in operation. The recent reduction in the price of hematite has not been of any benefit so far. Some interest has been aroused by a report that it has been proposed to institute arrangements in the London metal market for a resumption of the procedure of dealing in warrants, and there is a possibility—vague, perhaps—that the pig iron ring in Glasgow might be revived. It has been suggested that although trade in Scotland might not, in its present depressed condition, benefit to any extent the dealings of merchants might be facilitated.

### Scrap.

Movements in scrap have been a little freer of late. Prices are inclined to harden a trifle, but are still nominally in the region of 47s. 6d. for cast iron machinery, and 35s. per ton heavy steel.

### Coal.

Very little business has been done in export during the past week owing to the scarcity of fuel. Very few inquiries have been received from abroad and at present prices for forward transactions are practically ruled out. Activities have been almost entirely confined to the completion of cargoes due this month, and some difficulty has been experienced here, as even fuels not fully taken up could only be obtained in small lots.

### Restricted Working Under Coal "Quota."

Miners in all districts in Scotland have suffered curtailment of employment as a result of the output quota fixed under the Mines Act, 1930, but, perhaps, the greatest restriction of working has been experienced in Fifeshire. At any rate, a report of the state of affairs at the Wemyss Colliery offers an outstanding example. Just prior to the coming into operation of the marketing scheme, the production from the New Michael Colliery was expanding day by day, and miners were to be transferred from the older pits. The management being disappointed with the quota allocation by the Scottish Board in January, 1931, 450 men were dismissed and a rigid five-days working week introduced at all pits. Subsequently, further suspensions became necessary, and in last October 550 miners lost their employment for a period of three months, representing a sum in wages alone amounting to £25,000. Further, it is now computed that those suspensions will not keep production within the quota, and it may become necessary to suspend operations at all the pits some days before the New Year holidays, thereby affecting some 4000 workers. The company had received the full allowance possible under the scheme, but this was not enough to meet the expanding output. Similar conditions, on a smaller scale, are reported from the Lothians.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

### The Coal Trade.

COAL-EXPORT operations have been quieter than was expected, in view of the holidays. It was thought that owing to the recent bad weather and the delay which tonnage experienced, there would have been a rush of steamers immediately before the vacation, but such was not the case. As a matter of fact, just before the holidays there were no less than twenty-eight idle tipping appliances, and only one steamer waiting to berth at Port Talbot. As a consequence, collieries were able to deal fairly comfortably with the steamers which they had to load, but more pressure was looked for when the pits resumed work on Wednesday. Business in all the circumstances has been on a negligible basis for early shipment, and it cannot be said that much in the way of contract business has developed. It now transpires that in regard to the deal arranged on a barter basis in respect of Welsh coals for the Newfoundland National Railways in return for pit props, the quantities have been increased. The quantity of Welsh coal which will be shipped next season from this area to various ports in Newfoundland by Gueret, Llewellyn and Merrett, Ltd., of Cardiff, will be about 50,000 tons in exchange for about 100,000 tons of pitwood. Negotiations have also recently been in progress for the supply of 120,000 tons of Welsh coals for the Brazilian Central Railways to be paid for in coffee, but the deal did not come through, owing to the difficulty experienced in disposing of more coffee in this country. As a result therefore the Brazilian Railways have decided to exercise their option under last year's contract, and take further supplies of German coals on barter conditions for coffee. It certainly came as a surprise to this market last week when it became known that a German firm had submitted the lowest prices for coals for the requirements of the Egyptian State Railways, viz., 60,000 metric tons, to be delivered over the first three months of 1933 at Alexandria. Their prices were 23s. c.i.f. and 17s. 4½d. f.o.b., while the lowest c.i.f. price for Welsh locomotive coal was 24s. 3d. put in by Messrs. T. Beynon and Co., the lowest f.o.b. price being submitted by Messrs. Tabb and Burletson of 17s. 10d. So far, the business has not been allocated, but despite the aggressive efforts of the Germans to capture the order, strong hopes are held that the railways will place the business for Welsh coals in view of their superior quality.

### Peace in the Coalfield.

Exactly how things stand in regard to the termination of coalfield agreements has often been discussed, but it is very satisfactory to be able to say that, barring something unforeseen, there is the prospect of peace prevailing in the South Wales coalfield throughout the whole of 1933. This should, of course, be helpful to business, and relieve the minds of any foreign consumers of fears they may entertain that supplies of Welsh coals may be cut off from them. The representatives of the South Wales coalowners and workmen are to be commended on their decision last week to issue a joint statement on the subject, the mere fact that they agreed on this course being an indication of the desire on the part of both sides to maintain peaceful conditions and friendly relationship. The meeting held was that of the joint Disputes Committee, and the discussion on the point was initiated by the chairman of the owners' side, who explained that although the owners were entitled under the terms of the existing Conciliation Board Agreement to make an application for a review of the present minimum percentage and the amount of the subsistence wage, and, failing agreement, to refer the points at issue to the independent chairman, they had, after careful consideration, decided not to do so, in order that no uneasiness should be created in regard to the possible continuity of work. In the course of the subsequent discussion, the owners' representatives expressed the desirability of having a general discussion on the whole question of the Conciliation Board agreement with the definite object of endeavouring to ensure that the period of stability was extended far beyond 1934, while attempts to create the impression in some quarters that unrest was possible were deprecated. Point was further made of the fact that the Conciliation Board agreement does not automatically come to an end. It cannot possibly end until February, 1934, and even then it will not end unless one side or the other decides to terminate it.

### Development Work.

Following upon the activities of the South Wales and Monmouthshire Regional Industrial Council to foster new industries, &c., in this area, comes the announcement that this organisation is organising an Industrial Research Bureau, which will from time to time make detailed investigations into the conditions necessary for the extension of the existing industries and the development of new ones. The Council desires to have intimation of any prospective developments in other areas which might possibly be diverted to South Wales and Monmouthshire.

### Miscellaneous Items.

Rather more than a week ago Locket's Merthyr Collieries closed down. These collieries, which were restarted only a few months ago, are at Mardy, a hotbed of Communism. Two rival factions have sprung up among the men employed at the pits, one favouring the Communists and the other belonging to the Miners' Federation. Although no official statement has been issued by the owners of the collieries, it is understood that the existence of the two factions makes it impossible to carry on negotiations for the settlement of price-lists and other matters, and consequently the collieries have been closed down for the time being. For some months past negotiations have been proceeding between the employers and the representatives of the various unions for revised working conditions in the ship-repairing and engineering industry of this district, and it is now understood that these negotiations are nearing their final stage, with the expectation that they will be completed by the New Year. This will mean that the new tariff of ship-repairing costs will enable South Wales to compete more successfully for orders. When the Joint Standing Committee for the Welsh tin-plate trade met last week at Swansea, one of the subjects discussed was an application by the men for an investigation with the object of bringing about standardisation as regards wages and conditions of gantry men drivers, with a view to classification at different works. The employers intimated that they could not agree to the application.

### Coal Quotas.

Publicity having been given to the statement that the coal quota system so far as the export trade is concerned has come to an end, an official announcement that such is not the case is of special interest to South Wales which relies mainly upon its export business. The statement issued by the coalowners shows that there has been no drastic change in policy. It has always been the practice and is the duty of the Central Council to consider any applications for increased quotas, and if good reason is shown the applications have always been granted. It is pointed out that only recently quotas have been increased, and applications in the future will be considered on their merits.

### Current Business.

Actual new business has been extremely limited during the past week or so, but the firmness of sized descriptions, especially low volatile sorts has been maintained. It is expected that operations will not become normal until the New Year, owing to the holidays. Patent fuel and coke have shown no alteration, but pitwood is easier at 25s. to 25s. 6d., with prices displaying a tendency to weaken further.

## BRITISH STANDARDS INSTITUTION.

*All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.*

### POLES FOR TELEGRAPHS AND TELEPHONES.

No. 471—1932. This is virtually a supplement to B.S. Specification No. 134, which was issued a few years ago and dealt with longer and stronger poles than those covered by B.S.S. No. 471. The poles described in the new specification are intended primarily for use in sparsely populated regions and where cheapness in first cost and lightness (to reduce transport charges) are the essential factors. This type of pole has been extensively used in South Africa for many years, and the specification used by the Department of Posts and Telegraphs, South Africa, was largely taken as a basis for the B.S. Specification. Each pole consists of a cast iron base and a steel upper tube, the joint between these two parts being made by means of a wedge. The pole is completed by the addition of a cap, which may, if desired, be provided with a lightning rod. The dimensions of each component are specified and tests for the strength of the pole are included.

## LAUNCHES AND TRIAL TRIPS.

HILBRE ISLAND, suction sand dredger; built by Cammell Laird and Co., Ltd., to the order of Mersey Docks and Harbour Board; dimensions, 330ft. by 54ft. by 22ft. Engines, triple-expansion; constructed by the builders; launch, December 14th.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE UNDERFEED STOKER COMPANY, Ltd., asks us to say that the sluice ash-handling plant at the Batterses power station (see THE ENGINEER, December 2nd) was designed, manufactured, and installed by it as sub-contractor to Babcock and Wilcox, the main contractors for the boilers.

SIR HOLBERRY MENSFORTH has been elected a director of Edmundsons Electricity Corporation, Ltd., and of the Shropshire, Worcestershire and Staffordshire Electric Power Company, and has been appointed chairman of each of these companies. In order to enable him to devote the necessary time to his new activities, Sir Holberry Menaforth will resign the chairmanship of the English Electric Company, Ltd., but will remain on the board.

THE Committee of Lloyd's Register of Shipping announces the appointment of Mr. A. Arthur A. Chalmers as a Principal Surveyor on the Chief Engineer Surveyor's staff in London. Mr. Chalmers was apprenticed with George Clark, Ltd., Sunderland, and afterwards spent two years at the Royal College of Science, London, for theoretical training in all branches of engineering. After service at sea and gaining his Chief Engineer's certificate, Mr. Chalmers was for two years a designer in the engine works drawing-office of Harland and Wolff, Ltd., at Belfast. He began his service with Lloyd's Register as a Ship and Engineer Surveyor at Glasgow in March, 1906, and afterwards served at Cardiff, London, Antwerp, Sheffield, and Manchester. From 1917 until 1922 he represented the Society at Barcelona, and since 1922 has been stationed in London. He was promoted to be a Senior Surveyor in June, 1920, and in October, 1925, was appointed Senior Engineer Surveyor on the London outdoor staff.

## CALENDARS, DIARIES, &c.

ASHWELL AND NESBIT, Ltd., Leicester.—Wall calendar.

AUTOMATIC ELECTRIC COMPANY, Ltd., Liverpool.—Greeting card.

BRITISH THOMSON-HOUSTON COMPANY, Ltd.—Greeting card.

CLAYTON, SON AND CO., Ltd., Hunslet, Leeds.—Calendar, 1933–1936.

COUNTY OF LONDON ELECTRIC SUPPLY COMPANY, Ltd., New Broad-street, E.C.2.—Greeting card and telephone card.

CROFTS (ENGINEERS), Ltd., Bradford.—Wall calendar.

DEMAG. AKTIENGESELLSCHAFT, Duisburg.—Refill for desk calendar.

DEXINE, Ltd., Stratford, London.—Wall calendar.

D.P. BATTERY COMPANY, Ltd., Bakewell, Derbyshire.—Wall calendar.

ENGLISH STEEL CORPORATION, Ltd., Vickers Works, Sheffield.—Greeting card.

SOUTHERN RAILWAY PUPILS AND PREMIUMS DINNER.—The eighth annual dinner of the Southern Railway Pupils and Premium Apprentices' Association is to be held on Friday, February 3rd, 1933, at the Charing Cross Hotel, London, W.C.2. It is hoped that as many as possible of the ex-pupils and premium apprentices of the Southern Railway and its former constituent companies will attend this reunion function. Applications for tickets, which are 10s. 6d. each, should be made to the Secretary of the Dinner Committee, Mr. E. Forge, of 159, Desborough-road, Eastleigh.

# Current Prices for Metals and Fuels.

## IRON ORE.

| | |
|---|---|
| N.W. COAST— | |
| (1) Native | 15/6 to 20/– |
| (1) Spanish | 17/– to 24/– |
| N.E. COAST— | |
| Native | 18/– to 21/– |
| Foreign (c.i.f.) | 15/– |

## PIG IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| (2) SCOTLAND— | | |
| Hematite | 3 6 0 | — |
| No. 1 Foundry | 3 10 0 | — |
| No. 3 Foundry | 3 7 6 | — |
| N.E. COAST— | | |
| Hematite Mixed Nos. | 2 19 0 | 2 19 0 |
| No. 1 | 2 19 6 | 2 19 6 |
| Cleveland— | | |
| No. 1 | 3 1 0 | 3 1 0 |
| Siliceous Iron | 3 1 0 | 3 1 0 |
| No. 3 G.M.B. | 2 18 6 | 2 18 6 |
| No. 4 Foundry | 2 17 6 | 2 17 6 |
| No. 4 Forge | 2 17 0 | 2 17 0 |
| Mottled | 2 16 6 | 2 16 6 |
| White | 2 16 6 | 2 16 6 |
| MIDLANDS— | | |
| (c) Staffs.— | (*Delivered to Station.*) | |
| All-mine (Cold-blast) | — | — |
| North Staffs. Forge | 3 1 0 | — |
| „ „ Foundry | 3 6 0 | — |
| (c) Northampton— | | |
| Foundry No. 3 | 3 2 6 | — |
| Forge | 2 17 6 | — |
| (c) Derbyshire— | | |
| No. 3 Foundry | 3 6 0 | — |
| Forge | 3 1 0 | — |
| (3) Lincolnshire— | | |
| No. 3 Foundry | — | — |
| No. 4 Forge | — | — |
| Basic | — | — |
| (4) N.W. COAST— | | |
| N. Lancs. and Cum.— | | |
| Hematite Mixed Nos. | 3 15 6 (a); 4 0 6 (b); 4 5 6 (c) | — |

## MANUFACTURED IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| SCOTLAND— | | |
| Crown Bars | 9 15 0 | 9 5 0 |
| Best | — | — |
| N.E. COAST— | | |
| Iron Rivets | 11 5 0 | — |
| Common Bars | 9 5 0 | — |
| Best Bars | 10 5 0 | — |
| Double Best Bars | 10 15 0 | — |
| Treble Best Bars | 11 5 0 | — |
| LANCS.— | | |
| Crown Bars | 9 15 0 | — |
| Best Bars | 10 5 0 | — |
| Hoops | 12 0 0 | — |
| S. YORKS.— | | |
| Crown Bars | 9 15 0 | — |
| Best Bars | 10 15 0 | — |
| Hoops | 12 0 0 | — |
| MIDLANDS— | | |
| Crown Bars | 9 0 0 to 9 15 0 | — |
| Marked Bars (Staffs.) | 12 0 0 | — |
| Nut and Bolt Bars | 8 0 0 to 8 10 0 | — |
| Gas Tube Strip | 10 7 6 to 10 10 0 | — |

## STEEL. (*d*)

| | (6) Home. £ s. d. | (7) Export. £ s. d. |
|---|---|---|
| (5) SCOTLAND— | | |
| Boiler Plates (Marine) | 9 0 0 | 8 10 0 |
| „ „ (Land) | — | — |
| Ship Plates, ¾in. and up | 8 15 0 | 7 15 0 |
| Sections | 8 7 6 | 7 7 6 |
| Steel Sheets, ¼in. | 7 15 0 | 7 15 0 |
| Sheets (Gal. Cor. 24 B.G.) | 11 5 0—10 Ton Lots and Upwards Delivered Glasgow Stations. | 10 0 0 |
| „ (Gal. Cor. 24 B.G.) | For Canada | 10 15 0 |

## STEEL (*continued*).

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| N.E. COAST— | | |
| Ship Plates | 8 15 0 | 7 15 0 |
| Angles | 8 7 6 | 7 7 6 |
| Boiler Plates (Marine) | 10 10 0 | — |
| „ „ (Land) | 10 0 0 | — |
| Joists | 8 15 0 | 7 7 6 |
| Heavy Rails | 8 10 0 | — |
| Fish-plates | 12 0 0 | — |
| Channels | 10 5 0 | £9 to £9 5s. |
| Hard Billets | 7 2 6 | — |
| Soft Billets | 5 10 0 | — |
| N.W. COAST— | | |
| BARROW— | | |
| Heavy Rails | 8 5 0 | — |
| Light Rails | 8 10 0 to 8 15 0 | — |
| Billets | 6 10 0 to 9 0 0 | — |
| MANCHESTER— | | |
| Bars (Round) | 9 7 6 | — |
| „ (Small Round) | 7 0 0 | — |
| Hoops (Baling) | 10 0 0 | 9 15 0 |
| „ (Soft Steel) | 9 0 0 | 8 15 0 |
| Plates | 8 17 6 to 9 2 6 | — |
| „ (Lancs. Boiler) | 8 10 0 | — |
| SHEFFIELD— | | |
| Siemens Acid Billets | 9 2 6 (basis) | — |
| Hard Basic | 8 2 6 and 8 12 6 | — |
| Intermediate Basic | 6 12 6 and 7 2 6 | — |
| Soft Basic | 5 15 0 | — |
| Hoops | 9 10 0 to 9 15 0 | — |
| Soft Wire Rods | 7 10 0 | — |
| MIDLANDS— | | |
| Small Rolled Bars (all British) | 7 0 0 to 7 5 0 | — |
| Small Re-rolled Bars | 6 15 0 | — |
| Billets and Sheet Bars | 4 17 6 to 5 7 6 | — |
| Galv. Sheets | 11 15 0 to 13 15 0 | 10 10 0 |
| (2) Staffordshire Hoops | 9 10 0 | — |
| (*d*) Angles | 8 7 6 | — |
| (*d*) Joists | 8 15 0 | — |
| (*d*) Toes | 9 7 6 | — |
| (*d*) Bridge and Tank Plates | 8 17 6 | — |
| Boiler Plates | 8 7 6 to 8 10 0 | — |

## NON-FERROUS METALS.

| | |
|---|---|
| SWANSEA— | |
| Tin-plates, I.C., 20 by 14 f.o.b. | 15/9 to 16/3 |
| Block Tin (cash) | 149 0 0 |
| „ (three months) | 150 10 0 |
| Copper (cash) | 28 13 9 |
| „ (three months) | 29 0 0 |
| Spanish Lead (cash) | 11 3 9 |
| „ „ (three months) | 11 11 3 |
| Spelter (cash) | 15 8 9 |
| „ (three months) | 15 8 9 |
| MANCHESTER— | |
| Copper, Best Selected Ingots | 33 10 0 |
| „ Electrolytic | 34 10 0 |
| „ Strong Sheets | 65 0 0 |
| „ Tubes (Basis Price), lb. | 0 0 10 |
| Brass Tubes (Basis Price), lb. | 0 0 9 |
| „ Condenser, lb. | 0 0 11½ |
| Lead, English | 12 15 0 |
| „ Foreign | 11 7 6 |
| Spelter | 15 12 6 |
| Aluminium (per ton—raw ingot) | £95 |

## FERRO ALLOYS.

| | |
|---|---|
| Tungsten Metal Powder | 1/10½ per lb. |
| Ferro Tungsten | 1/7½ per lb. |

| | Per Ton. | Per Unit. |
|---|---|---|
| Ferro Chrome, 4 p.c. to 6 p.c. carbon | £25 15 0 | 8/– |
| „ „ 6 p.c. to 8 p.c. | £24 10 0 | 7/6 |
| „ „ 8 p.c. to 10 p.c. | £22 5 0 | 7/– |
| „ „ Specially Refined | | |
| „ „ Max. 2 p.c. carbon | £36 10 0 | 11/– |
| „ „ „ 1 p.c. carbon | £42 12 0 | 14/– |
| „ „ „ 0·70 p.c. carbon | £44 0 0 | 16/– |
| „ „ „ carbon free | 1/– per lb. | |
| Metallic Chromium | 2/9 per lb. | |
| Ferro Manganese (per ton) | £10 15 0 for home | |
| „ „ „ | £9 15 0 for export | |
| „ Silicon, 45 p.c. to 50 p.c. | £13 10 0 scale 5/– per unit | |
| „ „ 75 p.c. | £19 10 0 scale 6/– per unit | |
| „ Vanadium | 12/6 per lb. | |
| „ Molybdenum | 6/3 per lb. | |
| „ Titanium (carbon free) | 9d. per lb. | |
| Nickel (per ton) | £245 0 0 | |
| Ferro Cobalt | 7/9 per lb. | |

## FUELS.

### SCOTLAND.

| | Export. |
|---|---|
| LANARKSHIRE— | |
| (f.o.b. Glasgow)—Steam | 15/– |
| „ „ Ell | 16/– to 16/6 |
| „ „ Splint | 16/6 to 17/6 |
| „ „ Trebles | 15/– to 16/– |
| „ „ Doubles | 12/6 to 13/– |
| „ „ Singles | 11/6 |
| AYRSHIRE— | |
| (f.o.b. Ports)—Steam | 14/6 |
| „ „ Jewel | 16/6 |
| „ „ Trebles | 15/6 to 16/– |
| FIFESHIRE— | |
| (f.o.b. Methil or Burntisland)—Steam | 13/– to 15/– |
| Screened Navigation | 16/6 to 17/6 |
| Trebles | 17/– to 18/6 |
| Doubles | 13/6 to 14/6 |
| Singles | 11/6 to 12/– |
| LOTHIANS— | |
| (f.o.b. Leith)—Best Steam | 14/– |
| Secondary Steam | 13/6 |
| Trebles | 15/6 to 16/– |
| Doubles | 12/– to 12/6 |
| Singles | 11/3 to 11/6 |

### (8) N.W. COAST— ENGLAND.

| | |
|---|---|
| Steams | 19/– to 23/6 |
| Household | 32/6 to 52/6 |
| Coke | 18/– to 22/6 |
| NORTHUMBERLAND— | |
| Best Steams | 14/6 |
| Second Steams | 12/6 to 12/9 |
| Steam Smalls | 8/6 |
| Unscreened | 12/6 to 13/– |
| Household | 27/– to 39/– |
| DURHAM— | |
| Best Gas | 14/6 |
| Second | 13/3 to 13/6 |
| Household | 25/– to 37/– |
| Foundry Coke | 24/– |

| SHEFFIELD— | Inland. | |
|---|---|---|
| Best Hand-picked Branch | 27/– to 28/– | — |
| South Yorkshire Best | 23/– to 24/– | — |
| South Yorkshire Seconds | 18/– to 21/– | — |
| Derbyshire Best House | 22/– to 23/6 | — |
| Derbyshire Best Brights | 18/– to 20/– | — |
| Screened Seconds | 17/6 to 19/– | — |
| Kitchen Coal | 16/6 to 17/6 | — |
| Best Screened Nuts | 17/– to 18/6 | — |
| Small Screened Nuts | 16/– to 16/6 | — |
| Yorkshire Hards | 17/– to 18/– | — |
| Derbyshire Hards | 17/– to 18/– | — |
| Rough Slacks | 8/6 to 9/6 | — |
| Nutty Slacks | 7/– to 8/6 | — |

Blast-furnace Coke (Inland) 10/– on rail at ovens
Furnace and Foundry Coke (Export), f.o.b., 14/6 to 15/6

### (9) SOUTH WALES.

| CARDIFF— | |
|---|---|
| Steam Coals : | |
| Best Smokeless Large | 19/6 to 19/9 |
| Second Smokeless Large | 18/9 to 19/6 |
| Best Dry Large | 19/– to 19/6 |
| Ordinary Dry Large | 17/9 to 18/3 |
| Best Black Vein Large | 18/3 to 18/6 |
| Western Valley Large | 17/9 to 18/– |
| Best Eastern Valley Large | 17/7½ to 17/9 |
| Ordinary Eastern Valley Large | 17/3 to 17/6 |
| Best Steam Smalls | 13/– to 13/6 |
| Ordinary Smalls | 11/– to 13/– |
| Washed Nuts | 20/– to 32/– |
| No. 3 Rhondda Large | 19/6 to 19/9 |
| „ „ Smalls | 15/– to 16/– |
| No. 2 „ Large | 17/– to 17/3 |
| „ „ Through | 15/6 to 16/– |
| „ „ Smalls | 14/– to 14/3 |
| Foundry Coke (Export) | 22/6 to 36/6 |
| Furnace Coke (Export) | 17/– to 18/– |
| Patent Fuel | 20/– |
| Pitwood (ex ship) | 25/– to 25/6 |
| SWANSEA— | |
| Anthracite Coals : | |
| Best Big Vein Large | 36/– to 38/6 |
| Seconds | 27/– to 34/– |
| Red Vein | 22/– to 26/6 |
| Machine-made Cobbles | 37/6 to 48/6 |
| Nuts | 36/6 to 48/6 |
| Beans | 28/6 to 32/6 |
| Peas | 19/6 to 21/– |
| Breaker Duff | 8/6 to 9/6 |
| Rubbly Culm | 8/6 to 9/– |
| Steam Coals : | |
| Large | 20/– to 20/6 |
| Seconds | 18/– to 20/– |
| Smalls | 11/6 to 13/– |
| Cargo Through | 16/– to 17/6 |

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 22/6 : Ordinary Ship, Bridge, and Tank Plates and Sections, 15/ if home consumers confine purchases from sociated British Steel Makers. (*e*) Delivered Black Country Stations.

## French Engineering Notes.

*(From our own Correspondent in Paris.)*

### Railway Reforms.

As the year ends the problem of saving the railway companies from financial disaster is no nearer solution than it was at the beginning, when it was already clear that they were heading straight for a catastrophe. The successive Governments and Parliament are alone, responsible for this state of things, for they are entire masters of the situation, and they have shown so much tergiversation that, during the past six months at least, it would almost seem as if the Socialist politicians were hoping that events would force upon the country a nationalisation of the railways. The reception of the proposal of the Minister of Public Works in the last Government to amalgamate all the companies indicated so plainly that the country would have nothing to do with it, that any idea of nationalisation is now definitely abandoned. All the Chambers of Commerce and other bodies which have expressed opinions on the matter urge the necessity of the railway companies being given a free hand to work out their own problems. At the annual meeting of the Presidents of all the Chambers of Commerce, a declaration was issued to the effect that the railways were working under conditions of economic inferiority. The railway system, the declaration states, comprises 19,565 kiloms. of two and three-track lines, and 20,555 kiloms. of single-track lines. These latter must necessarily continue to lose money. About 4000 kiloms. of line could be suppressed at once without causing inconvenience to anybody. The declaration is in favour of the railway companies being allowed to work out their own scheme of organisation. The national company, which it is proposed to create for road transport in association with the railways, is now opposed by the federation of road haulage interests on the ground that it will infallibly come under the control of the railway companies, but as the railway companies affirm that such fears are unfounded and as, moreover, the national company has become an integral part of the general scheme of organisation, the road interests cannot claim special privileges in a matter of national interest. All this will necessarily involve long discussion in the Chamber and the Senate, and the companies cannot obviously wait indefinitely for a complete solution of their difficulties. The crucial point at the moment is that since 1926, when the Government imposed a " temporary " exorbitant tax on passenger and goods traffic for the relief of the franc, which had dropped to a perilously low level, the State has extracted from the railway companies no less than 18,690 million francs. This is far in excess of the total railway deficits. The companies insist on the State sacrificing some of this revenue by reducing the traffic tax to its previous level. That is what the State cannot do at the present moment when the Government does not know which way to turn in order to make up for the huge Budget deficit. The chances of the railway companies obtaining early relief are, therefore, none too promising.

### Wagon Building.

So little money has been available for the renewal of rolling stock this year that wagon builders have been proposing to the Government different financial combinations whereby orders could be distributed without putting any present burden on the national finances. None of them has been accepted, and builders have been discharging men at a rate that promised to leave all the shops at a standstill during the winter. It is now stated that the Superior Railway Council has succeeded in obtaining permission to put in hand during 1933 a programme involving an expenditure of about 400 million francs. It will comprise sixty locomotives, 200 coaches, and 3000 trucks. This is a small amount of work in view of what had been agreed upon for distribution under the five years' purchasing programme, which has obviously now been abandoned, but it will, at all events, avoid the necessity of wagon builders closing down their shops.

### Civil Aviation.

The Government has published the statutes for civil aviation whereby the annual subsidies paid by the State to private companies will not exceed 200 million francs. Conventions may be entered into with companies, whose air lines offer sufficient guarantee of security for a period of fifteen years. The State will receive a number of shares equal to 25 per cent. of the total in return for the subsidies, and will be proportionately represented on the boards of directors. These statutes fixing the duration of the conventions to fifteen years will give satisfaction to the companies who have always complained that the short-term subsidies did not give them a fair chance to develop their services. The publication coincides with the Air Orient and the Air Union companies considerably increasing their respective capitals with the participation of the International Sleeping Car Company and navigation companies, and, in addition, the Air Orient has the Suez Canal Company as a shareholder.

### Flood Protection.

Some parts of the Midi have again been ravaged by floods, and as they have been of a particularly disastrous character during the past few years, it is assumed that they arise from special causes, the general theory being that extensive deforestation may have lessened the capacity of the land to retain water. The work of the forestry engineer, who is highly specialised, has, therefore, grown in importance, and the scientific laying out of woods and forests is being carried on systematically. If the rivers were free to carry off the water there would be no serious floods, and engineering skill has to be devoted to the removal of obstacles and the reconstruction of bridges that offer impediments. The most serious obstacles are the towns which strangle the rivers. No general scheme can be carried out for the prevention of floods, but they can be attenuated by the numerous partial works that are necessarily proceeding slowly on account of the cost. In the case of heavy floods there can be no immediate remedy. In the Roussillon, a bridge, 100 m. long, over the river Têt collapsed entirely under pressure of the flood.

## British Patent Specifications.

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.*

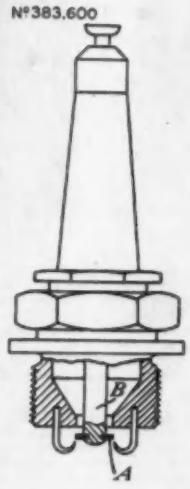
*The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.*

### INTERNAL COMBUSTION ENGINES.

383,600. September 17th, 1932.—SPARKING PLUGS, R. Bosch Aktiengesellschaft, 4, Militärstrasse, Stuttgart, Germany.

In sparking plugs which are employed in high-compression engines it is usual to employ an electrode of expensive material, such as platinum, which is secured to the central pin and soldering by riveting. It has been found that silver solder is not very durable at the temperatures obtaining in high-compression engines, and therefore the electrode becomes loose. This drawback does not occur in electrodes which, according to the invention, are soldered with a solder of gold and nickel. A small platinum plate A is riveted on to the end of the central electrode B and soldered with gold solder. It has been found that a gold solder particularly suitable for the present purpose consists of 50–60 per cent. of gold and 50–40 per cent. nickel.—*November 17th*, 1932.

Nº 383,600

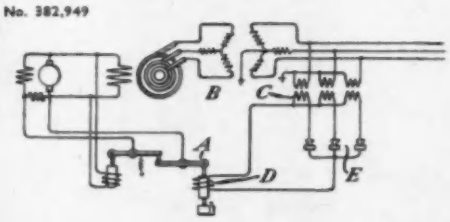



### DYNAMOS AND MOTORS.

382,949. May 12th, 1931.—AUTOMATIC REGULATORS FOR DYNAMO-ELECTRIC MACHINES, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

In accordance with this invention, means are provided whereby the regulator A of a polyphase generator B is made responsive to both balanced and unbalanced voltage variations without

No. 382,949

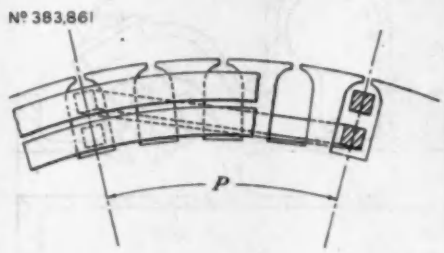



providing the regulator with as many separate control units as there are phases. As will be seen from the diagram, transformers C feed the main control element D of the regulator through rectifiers E. With this arrangement each secondary winding of the transformers E carries a current proportional to one of the plane voltages of the circuit, so that the control coil D carries a direct current which is proportional to the sum or mean value of these voltages.—*November 10th*, 1932.

383,861. April 5th, 1932.—MULTIPLE-CONDUCTOR SQUIRREL-CAGE TYPE INDUCTION MOTORS, Eiro Shigyo, of 12, Hakubun-cho, Tairen, South Manchuria.

According to this invention, in multiple-conductor squirrel-cage type induction motors the upper and lower rotor conductors spaced about one pole pitch P are successively connected in series on one side of the rotor, while on the other the conductors are short-circuited, or connected with one or more

Nº 383,861



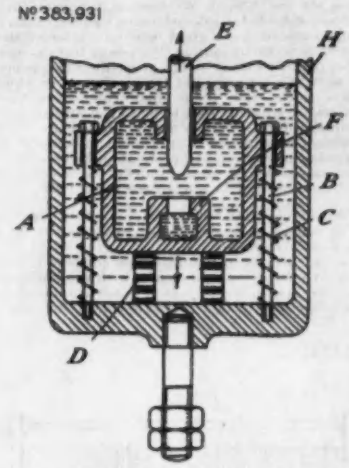

end rings. As one and the same current flows in the upper and lower rotor conductors, it is explained, and when starting the current is smaller than that of the upper rotor conductors and is larger than that of the lower rotor conductors as compared with the ordinary induction motors, the core parts surrounding the upper rotor conductors are protected from overheating and the motor starting torque is increased on account of increased resistance, chiefly reactance, of the rotor.—*April 5th*, 1932.

### SWITCHGEAR.

383,931. July 23rd, 1932.—LIQUID-BREAK ELECTRIC SWITCHES OF THE EXPLOSION CHAMBER TYPE, *International General Electric Company, Incorporated, of 120, Broadway, New York, U.S.A.*

The object of this invention is to render a liquid-break switch of the explosion chamber type capable of dealing with widely varying switching conditions. The explosion chamber A, which is filled with the liquid, is resiliently mounted on the two rods B by means of the springs C. The current supply to the stationary contact in the chamber may be effected by known means, such as the spirally wound metal strip D. As soon as the movable contact rod E leaves the fixed contact F, which is integral with the chamber, an arc is set up which generates vapour in the chamber A. The vapour pressure drives the chamber backwards in the direction indicated by the lower arrow. When the moving contact passes out of the chamber into the container H filled with liquid, the level of which is located above the chamber, the arc is drawn through the opening and is then rapidly extinguished by the jet of expanding

Nº 383,931




vapour. Owing to the fact that the moving contact, together with the blow-out member, move in the opposite direction to the contact rod, a high speed of rupture is also obtained.—*November 24th*, 1932.

### AERONAUTICS.

383,821. February 16th, 1932.—AEROFOILS, J. F. Ziegler, Schwarzenbergplatz 2, Vienna 1, Austria.

The inventor describes as a " transverse driven body " such a thing as an aeroplane wing or a boat's sail, and claims as follows :—" A transverse driven body with a streamline-shaped outline in cross section and with at least one conducting passage extending from the under to the upper side and forming a slot transverse to the direction of flight for a suction stream produced by the partial vacuum formed by the flow on the suction side,

Nº 383,821

characterised by the feature that between the inflow and outflow ends of said slot, of which both edges of the former lie within the outline of the bottom surface and the latter in the apical zone or the adjacent main zone of the top surface, a direction reversing passage is provided, which extends towards the front beyond the said inflow and outflow ends—for instance, a C-shaped transverse slot—so that the suction stream which sweeps in the first place forwards and after its reversal backwards leaves in the said apical or main zone."—*November 24th*, 1932.

### TRAMWAYS AND RAILWAYS.

383,124. February 8th, 1932.—PNEUMATIC TIRES FOR RAILWAYS, Micholin et Cie, Clermont-Ferrand, Puy-de-Dome, France.

In this rubber tire for railway service, a broad, flat tread is ensured by inserting in the tread a " member " A, which

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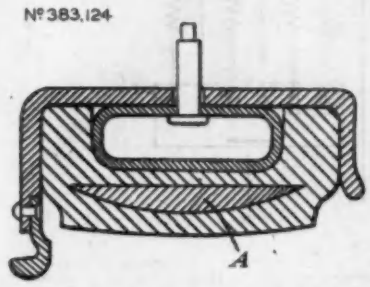


can be formed of canvas or other suitable material. Alternatively, it may be formed of cotton threads or wires extending circumferentially round the tire. It is essential, however, that the member be of sufficient rigidity to maintain the shape of the tire when inflated and/or under load.—*November 10th*, 1932.

### MISCELLANEOUS.

383,908. June 20th, 1932.—DEVICES FOR TRANSMITTING HIGH OR MEDIUM-FREQUENCY OSCILLATIONS ALONG POWER SUPPLY CIRCUITS, N. V. Philips' Gloeilampen-fabrieken, of Emmasingel 13D, Eindhoven, Holland.

In transmitting electric oscillations of high or medium

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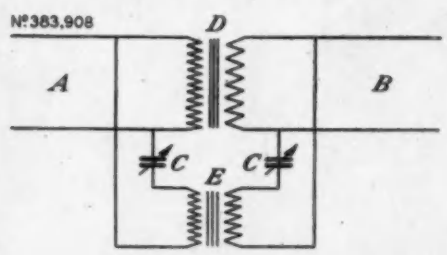
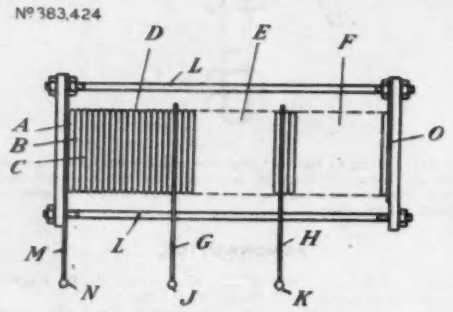



frequencies by way of power supply circuits the transformers practically always present in such supply circuits have to be bridged for the higher frequencies, as otherwise these frequencies would not pass. Hitherto this bridging has been effected by

means of condensers which are just large enough to allow the higher frequencies to pass, but constitute for the low frequencies of the supply circuit practically an infinitely high resistance. In cases, however, in which the impedances of the lines differ considerably from each other the method is impracticable. If, for example, the line A is an overhead high-tension line and if B is a low-tension cable loaded with many lighting units, motors, &c., the impedance of A is a great many times larger than that of B. According to the invention, the power transformer D has connected in parallel with it a high or medium-frequency transformer E, both the primary and the secondary of which have connected in series with them small condensers C. These condensers are variable in order to permit of adjusting them to current resonance for the high or medium-frequency oscillations. The transformer windings of E are caused to conform with the various impedances of A and B, preferably, by choosing a ratio of transformation which is substantially equal to the root of the quotient of the impedances.—*November 24th*, 1932.

383,424. November 20th, 1931.—MULTI-PHASE CONDENSERS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

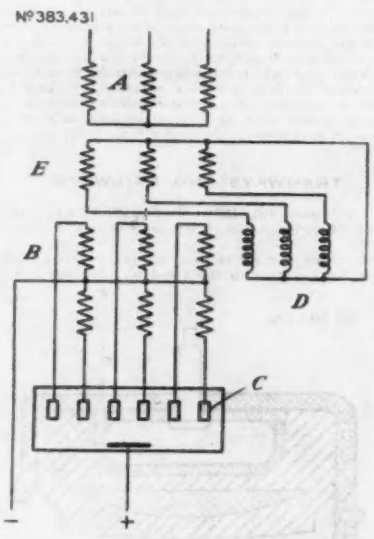
The invention relates to a multi-phase condenser, and more particularly to a three-phase condenser with windings connected in series. The condenser reels A B C are combined to form assemblies of reels D, E, and F (one assembly for each phase),




and arranged in series. Between the assemblies plates G and H are placed, and are connected to the phase terminals J and K. The clamping plates are interconnected by tie rods L and a plate M is connected with the phase terminal N, the plate being in connection with the phase connection O through the tie rods L. One of the tie rods L serves as a third point connection.—*November 17th*, 1932.

383,431. November 25th, 1931.—POLYPHASE CURRENT DISTRIBUTION CIRCUITS FOR MERCURY VAPOUR RECTIFIERS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

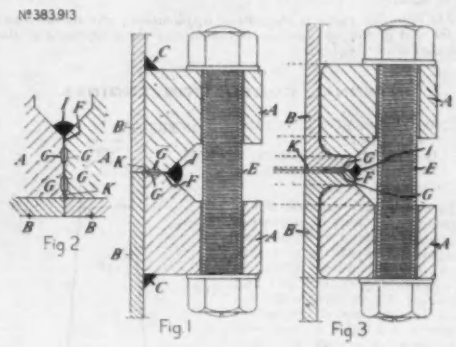
This specification describes a circuit for preventing the rise of potential with reduction of load or absence of load on a mercury arc rectifier. The primary star-connected winding of




the rectifier transformer is indicated by A and its secondary star-connected winding by B, to which the six anodes C of the rectifier are connected. In accordance with the invention, a system of choking coils D with highly saturated iron cores serves as supplementary apparatus for the purpose mentioned, the coils being connected to a special auxiliary winding E of the transformer.—*November 17th*, 1932.

383,913. June 25th, 1932.—PIPE JOINTS, Babcock and Wilcox, Ltd., Farringdon-street, London, E.C.4; and F. H. Smith.

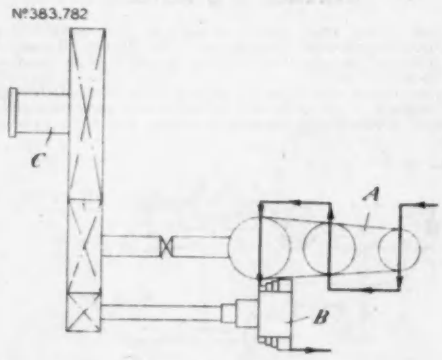
This invention relates to pipe joints with a seal weld and has for its object to provide a joint affording a certain degree of flexibility permitting the weld to be easily chipped out when it is necessary to break the joint, so that it is possible to break and re-make the joint many times without injury to the joint surfaces. A denotes the usual flanges which are fixed to the pipes B by welding at C and screwing or other method, which flanges are adapted to be drawn together by bolts E. In the embodiment illustrated in Fig. 3, A denotes the flanges which are loose on the pipes B, the ends of which are turned up and present shoulders engaged by the loose flanges A which are drawn together. The flanges or pipe ends are at the outer periphery so shaped as to leave a small gap F between the flange faces or pipe ends. On this portion of the flange faces or pipe ends channels or the like G are formed, which co-operate to provide spaces which, in conjunction with the gap F, provide for a certain degree of elasticity of the parts which are seal welded together at I. As indicated,




the gap extends preferably from the inner periphery of the channel to the outer periphery of the flange or pipe joint. With large flanges two annular channels may be provided by the faces of the flanges. A metal-to-metal joint is made at the inner periphery of the flange or pipe end, as indicated at K in the figures of the drawing. It will be seen that the weld can be chipped out easily when it is necessary to break joint, so that it is possible to break and make joint many times without injury to the joint surfaces.—*November 24th*, 1932.

383,782. January 7th, 1932.—POWER UNITS, W. A. White and White's Marine Engineering Company, Ltd., Prince Consort-road, Hebburn-on-Tyne.

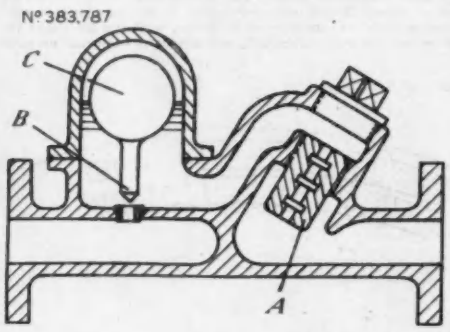
The inventors suggest the more or less familiar arrangement of a reciprocating engine A, exhausting into a low-pressure turbine B, both of which are geared with the propeller shaft C; but




they go on to make some very wide claims, including the use of an internal combustion engine in the place of a steam engine. Finally they say that a main object aimed at throughout is to run the reciprocating engine, the turbine, and the propeller shafts at speeds adapted to give the highest efficiency in each case, while at the same time securing compact arrangements of plant.—*November 24th*, 1932.

383,787. January 8th, 1932.—STEAM TRAPS, G. F. Gerdts, 31, Markusallee, Bremen-Horn, Bremen, Germany.

The inventor points out that one of the chief causes of trouble with steam traps is the high velocity of discharge, which causes




the erosion of the valve seating. He consequently arranges a choking device A in the inlet to the trap to check an excessive flow through the trap valve B, which is controlled by the float C. —*November 24th*, 1932.

## Forthcoming Engagements.

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "The Design of Kilns for the Seasoning of Timber," Mr. E. A. Steel. 7.30 p.m.

SATURDAY, DECEMBER 31ST.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Christmas Juvenile Lectures, "Round of the Water: (iii.) The Atmosphere," Prof. A. O. Rankine. 3 p.m.

**1933.**

TUESDAY, JANUARY 3RD.

INST. OF AUTOMOBILE ENGINEERS.—At Royal Soc. of Arts, Adelphi, W.C.2. "Electrical Equipment for Automobiles," Mr. E. A. Watson. 7.45 p.m.

WEDNESDAY, JANUARY 4TH.

INST. OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. "Electrical Equipment for Automobiles," Mr. E. A. Watson. 7.30 p.m.

FRIDAY, JANUARY 6TH.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Stress Recorders and their Use in Railway Bridge Work," Mr. G. F. Kent. 7.30 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "Liverpool Overhead Railway," Mr. J. Macnab. 7.30 p.m.

MONDAY, JANUARY 9TH.

CHARTERED SURVEYORS' INSTITUTION.—12, Great George-street, S.W.1. Meeting. 8 p.m.

INST. OF SANITARY ENGINEERS.—Caxton Hall, Westminster, S.W.1. Presidential Address, Mr. Henry C. Adams. 6 p.m.

TUESDAY, JANUARY 10TH.

INST. OF AUTOMOBILE ENGINEERS.—King's Head Hotel, Coventry. "Electrical Equipment for Automobiles." Mr. E. A. Watson. 7.30 p.m.

WEDNESDAY, JANUARY 11TH.

SOCIETY OF GLASS TECHNOLOGY: LONDON SECTION.—Holophane, Ltd., Elverton-street, S.W.1. Discussion, "Automatic Temperature Control of Direct-fired Furnaces," Mr. W. A. Moorehead. 7.30 p.m.

THURSDAY, JANUARY 12TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders Ltd., 83, Pall Mall, S.W.1. "The Zinc Industry," Mr. Stanley Robson. 7.30 p.m.

FRIDAY, JANUARY 13TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "The Compression-ignition Locomotive and its Applicability to British Railways," Lt.-Col. L. F. R. Fell, D.S.O. 6 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION (Joint meeting with Society of Chemical Industry).—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Corrosion of Metals in Salt Solutions and Sea Water," Dr. G. D. Bengough. 7.30 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-Ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Metal Spraying," Mr. Kenneth Gray. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Some Practical Notes on Vibration," Mr. J. Calderwood. 7.30 p.m.

MONDAY, JANUARY 16TH.

INST. OF AUTOMOBILE ENGINEERS.—At Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Electrical Equipment for Automobiles," Mr. E. A. Watson. 7.30 p.m.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Aluminium-bronze," Mr. F. Hudson. 7.30 p.m.

TUESDAY, JANUARY 17TH.

INST. OF AUTOMOBILE ENGINEERS.—Victoria Hotel, Wolverhampton. "Alloy Cast Irons in Automobile Construction," Dr. A. B. Everest. 7.30 p.m.

WEDNESDAY, JANUARY 18TH.

DIESEL ENGINE USERS ASSOCIATION.—Caxton Hall, S.W.1. "Small Marine Diesels," Mr. O. Wans. 3 p.m.

INST. OF AUTOMOBILE ENGINEERS.—Metropole Hotel, Leeds. "Electrical Equipment for Automobiles," Mr. E. A. Watson. 7.15 p.m.

THURSDAY, JANUARY 19TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the University, Edmund-street, Birmingham. "Moulding Sands," Dr. J. G. A. Skerl. 7 p.m.

THURSDAY, JANUARY 26TH.

INST. OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Royal Victoria Station Hotel, Sheffield. Annual dinner. 6.30 for 7 p.m.

FRIDAY, JANUARY 27TH.

INST. OF ELECTRICAL ENGINEERS.—Grand Hotel, Harrogate. Dinner and dance. 8 p.m.–2 a.m.

THURSDAY, FEBRUARY 2ND.

INST. OF AUTOMOBILE ENGINEERS.—Merchant Venturers' Technical College, Bristol. "Alloy Cast Irons in Automobile Construction," Dr. A. B. Everest. 7 p.m.

END OF VOL. CLIV.

Engineering Library

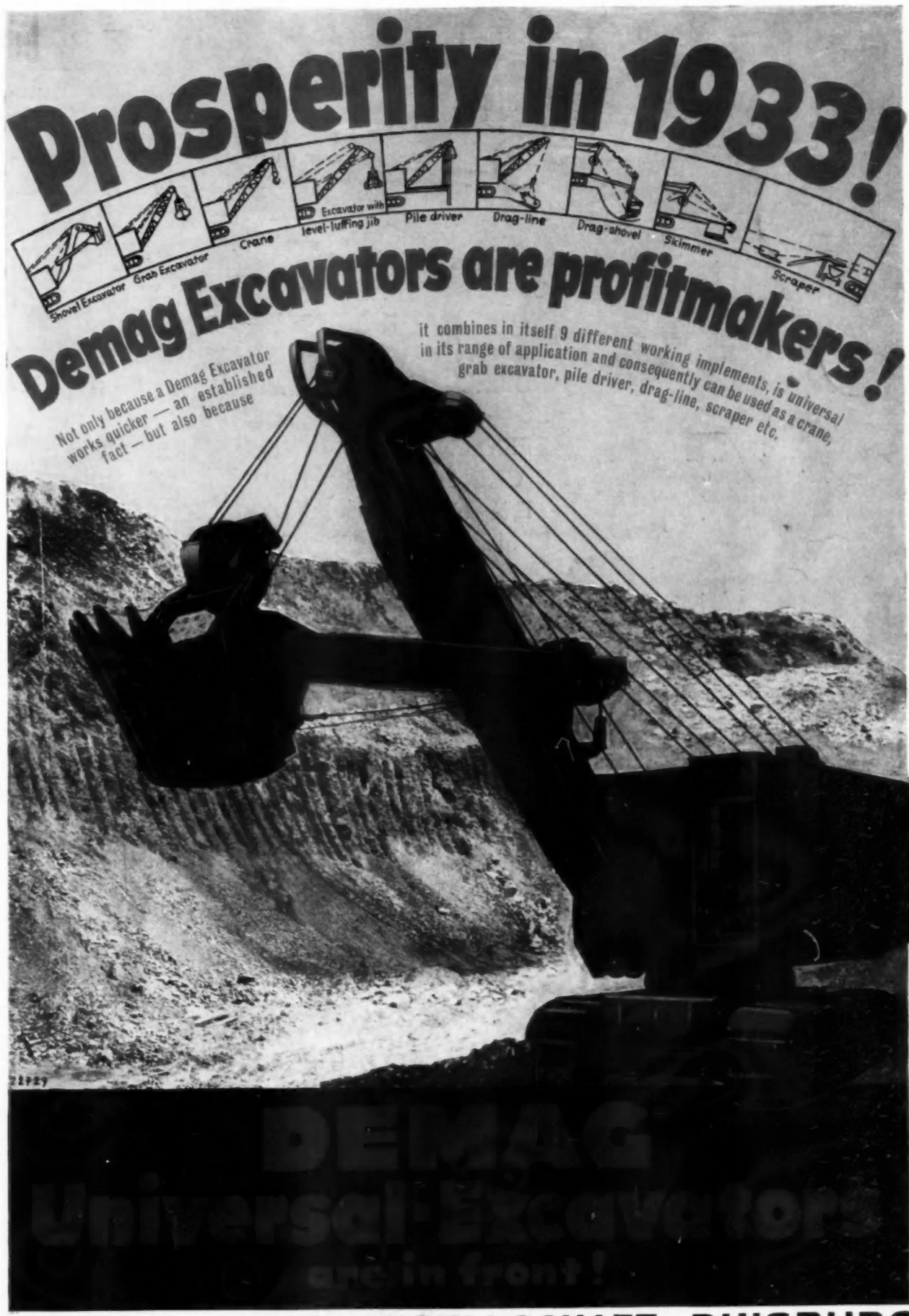
JAN 19 1933


# The Engineer

ESTABLISHED 1856. REGISTERED AS A NEWSPAPER.

VOL. CLIV.—No. 4016] 28, ESSEX ST., LONDON, W.C. 2. [DECEMBER 30, 1932

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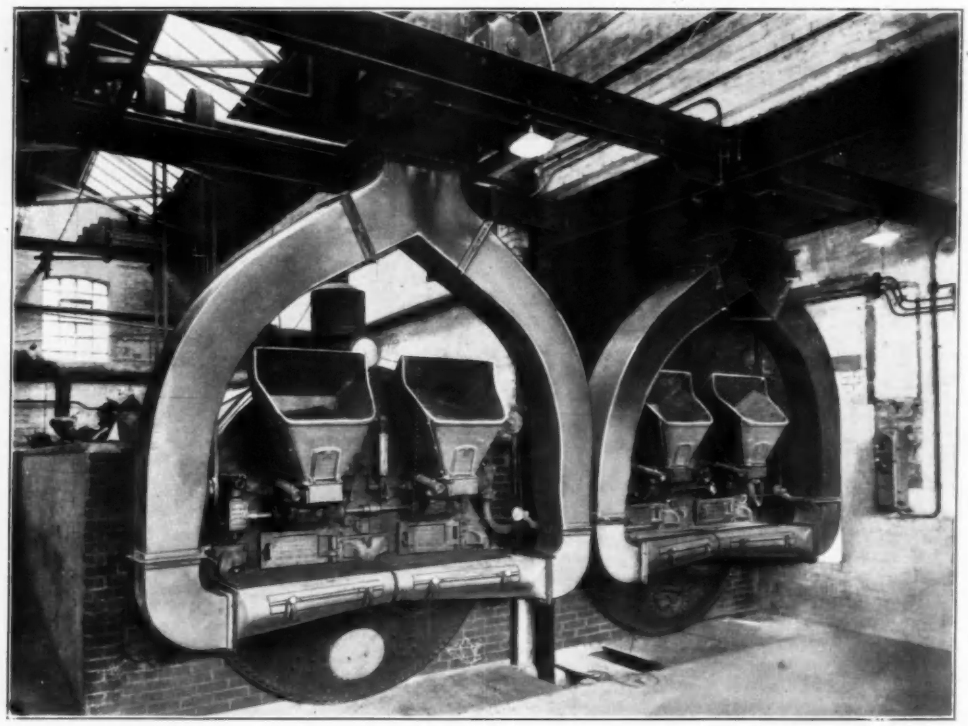

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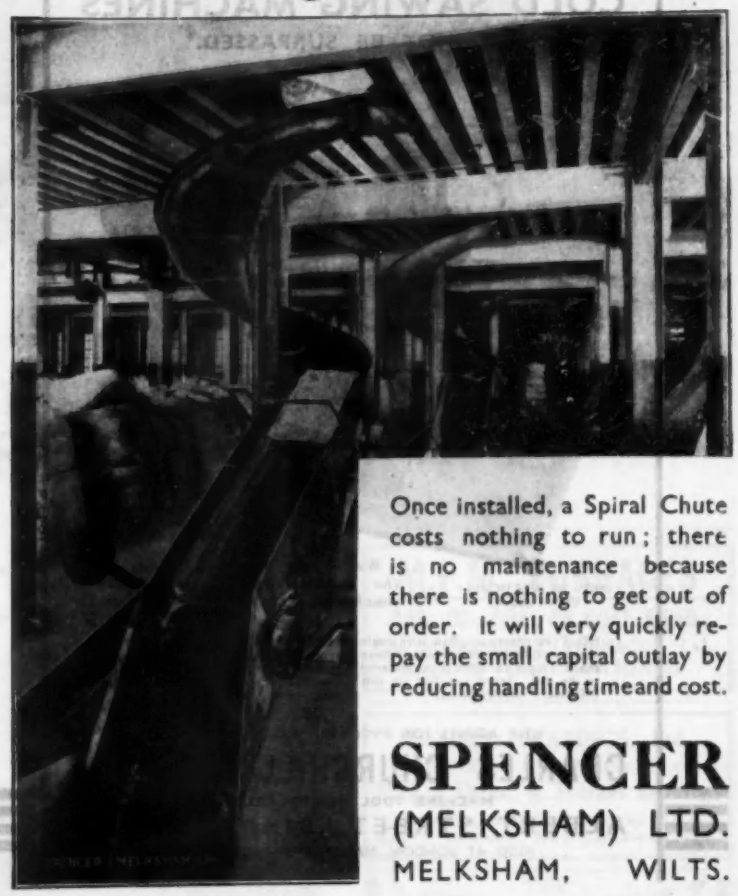

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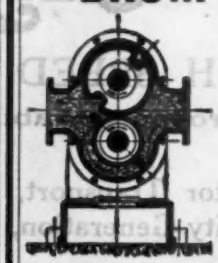

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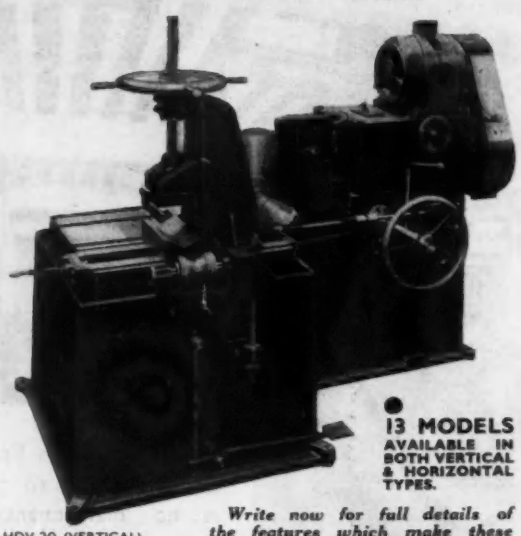

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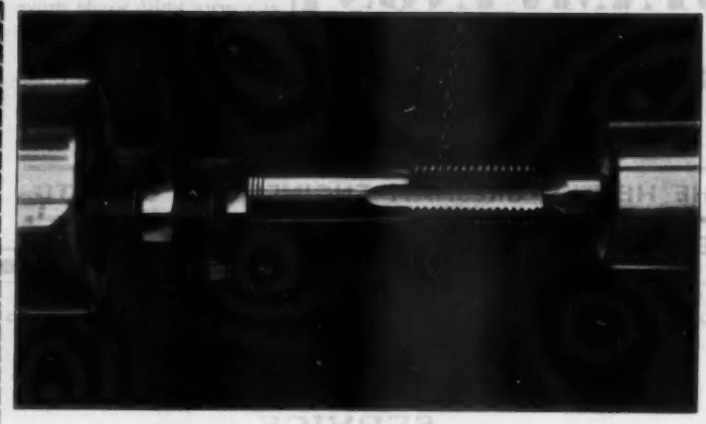

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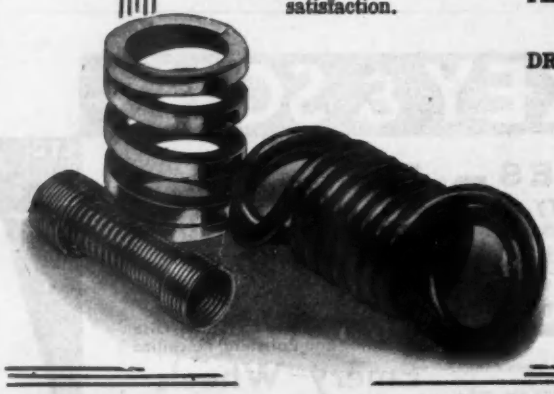

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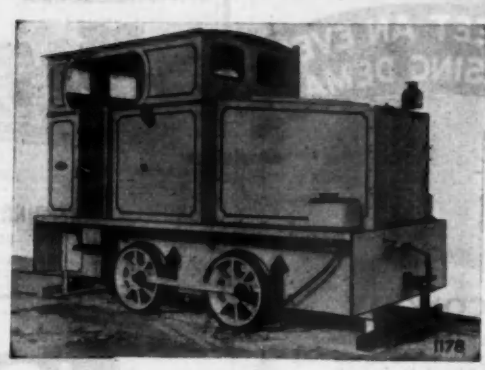

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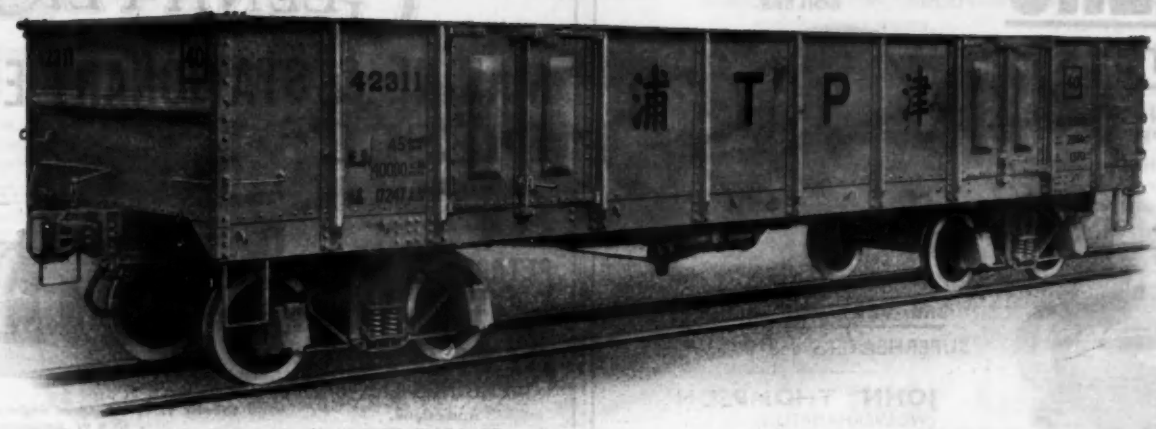


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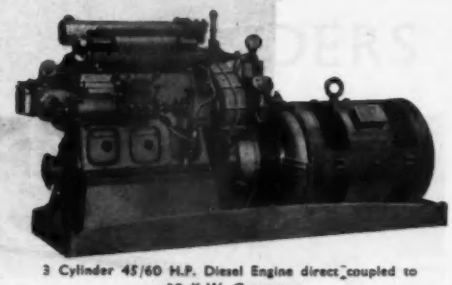

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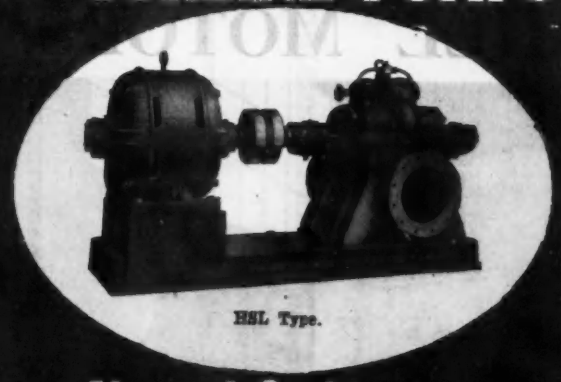

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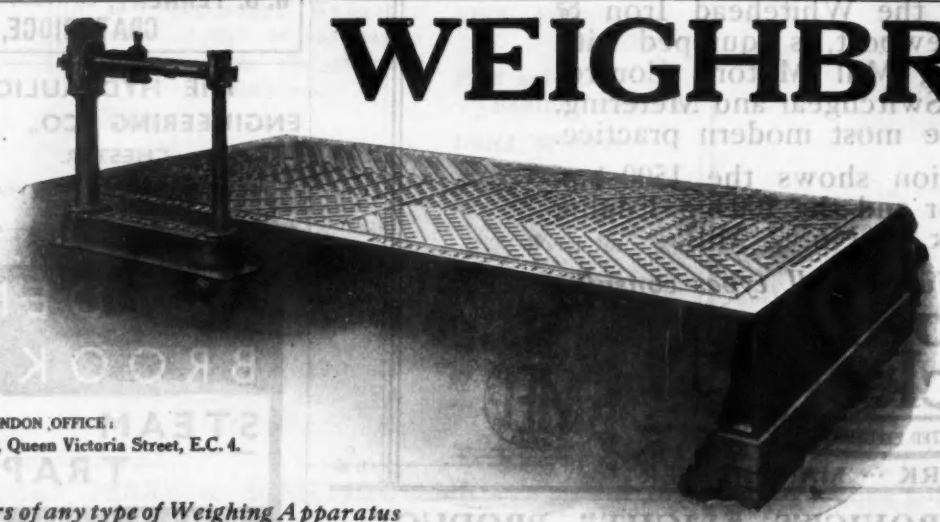

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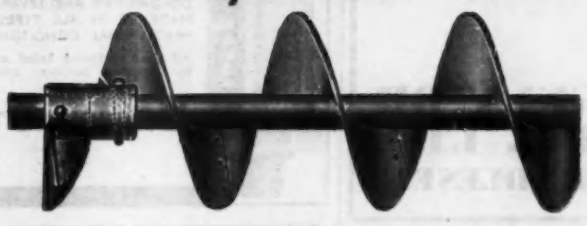

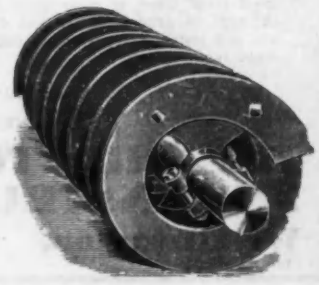

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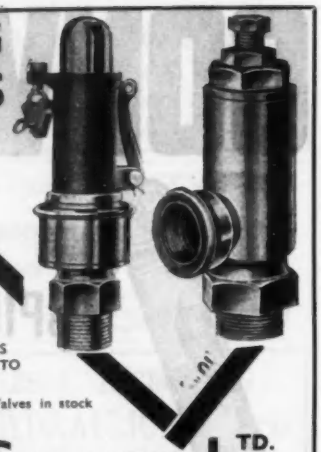

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Nitricastiron is a special alloy casting which can be surface hardened 'by the "Nitrarding" process to give a BRINELL HARDNESS OF 900—1,000 to a depth up to ·020".

The rod is readily machinable before hardening and by our special process of casting is rendered entirely free from blow holes and detrimental inclusions. It is supplied rough machined to $\frac{1}{32}$" above nominal diameter.

*Write for free sample and full particulars.*

**SHEEPBRIDGE STOKES CENTRIFUGAL CASTINGS CO., LTD.**

SHEEPBRIDGE WORKS, CHESTERFIELD.

## ENSURE A REGULAR and CORRECT LUBRICATION

by fitting the

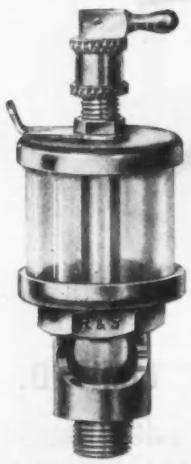

Illustration is exact size of article.

## "ROTHERHAM"

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## MIDGET SIGHT FEED LUBRICATOR

Saves its cost in a short space of time. No waste as in filling a blind oiler. Flow of oil can be controlled as desired.

**Supplied in standard threads.**

**Brass Finish 3/6 Polished Nickel Plate 3/9**

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## ● Stone and Gravel Plant

D12A

The Patent "ACME" Portable Granulating Outfit with Elevator, Screen, Bins and Rejection Returning Device. As supplied to Councils and Public Bodies at Home and Overseas.

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PATENT "ACME" "LEVER" & "BLAKE" BREAKERS, GRANULATORS, CRUSHING ROLLS AND ROTARY HAMMERS FOR STONE, ORE, GRAVEL, COKE, BRICK, ETC.

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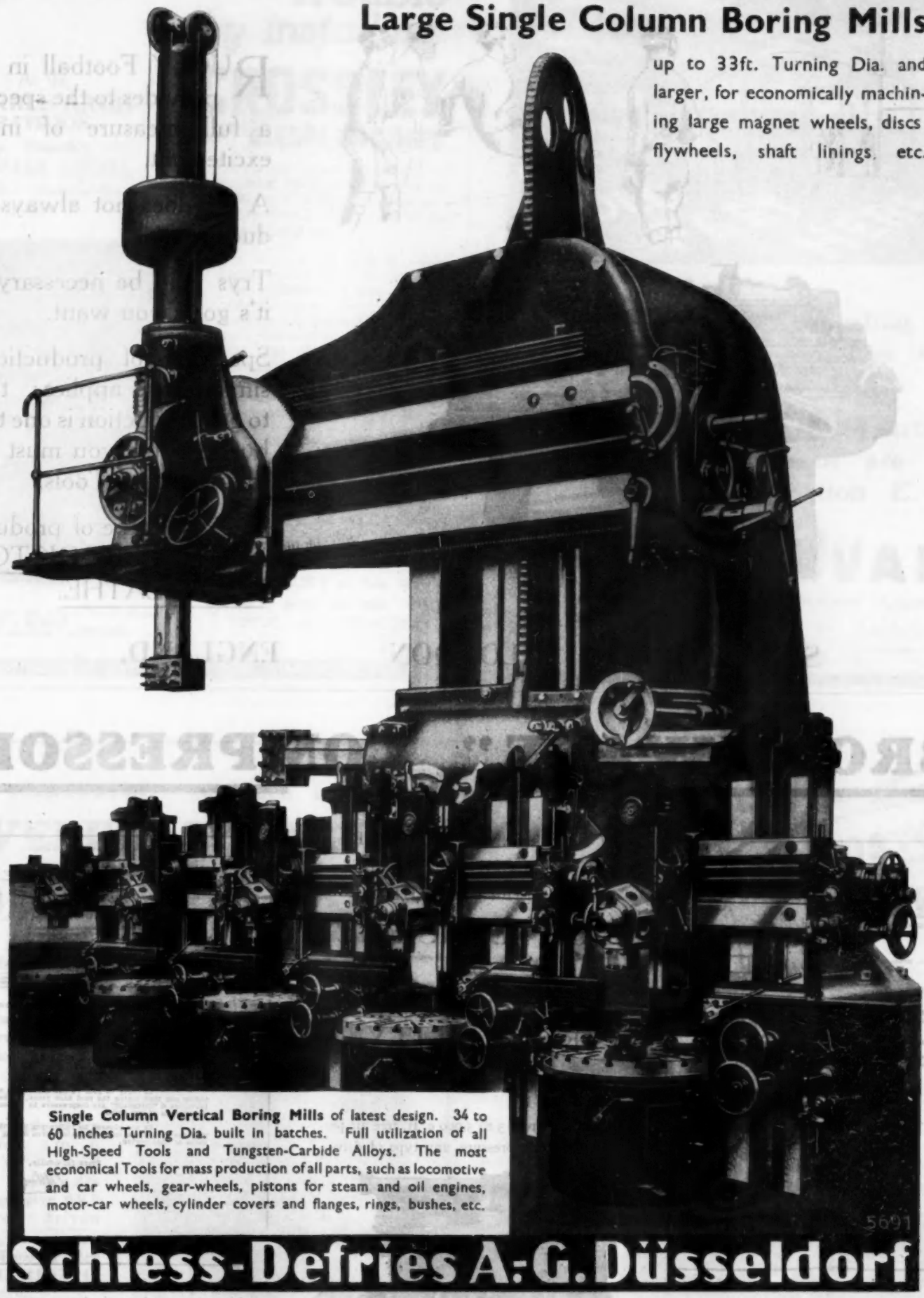
# Single Column Vertical Boring Mills

## Large Single Column Boring Mills

up to 33ft. Turning Dia. and larger, for economically machining large magnet wheels, discs flywheels, shaft linings, etc.



**Single Column Vertical Boring Mills** of latest design. 34 to 60 inches Turning Dia. built in batches. Full utilization of all High-Speed Tools and Tungsten-Carbide Alloys. The most economical Tools for mass production of all parts, such as locomotive and car wheels, gear-wheels, pistons for steam and oil engines, motor-car wheels, cylinder covers and flanges, rings, bushes, etc.

5691

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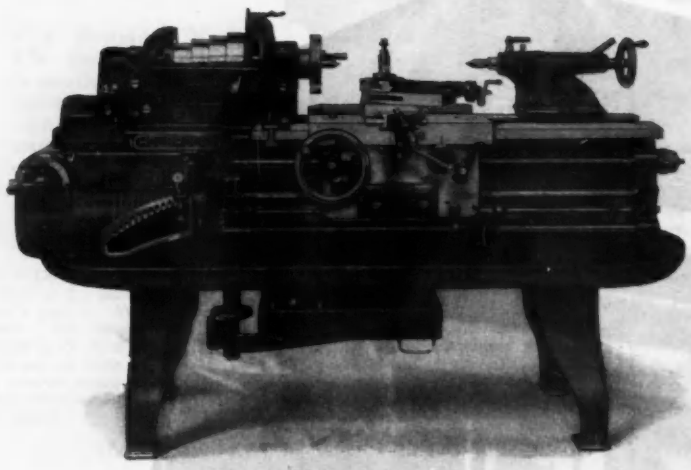
B

# HOLBROOK



MODEL T, No. 13.
13 inches swing by 24 inches between centres.

RUGBY Football in play provides to the spectator a full measure of intense excitement.

A try does not always produce a goal.

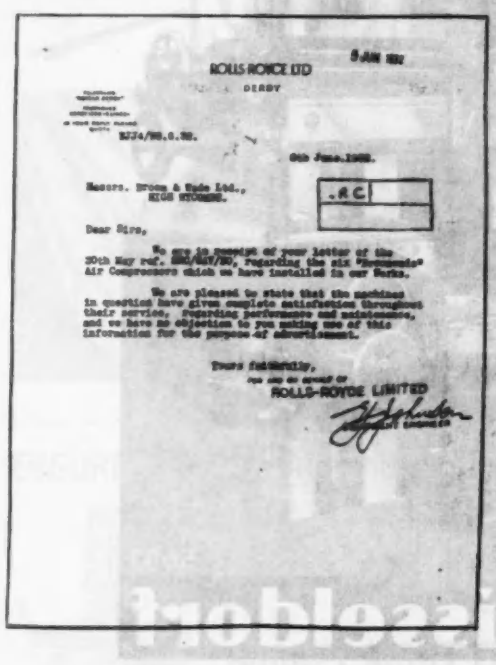
Trys may be necessary, but it's goals you want.

Speaking of production, a similar case applies; trying to get production is one thing, but to get it you must have the necessary Tools.

The goal lathe of production is the HOLBROOK TOOL-ROOM LATHE.

**STRATFORD LONDON ENGLAND.**

# "BROOMWADE" COMPRESSORS



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Messrs. Broom & Wade Ltd.,
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Dear Sirs,

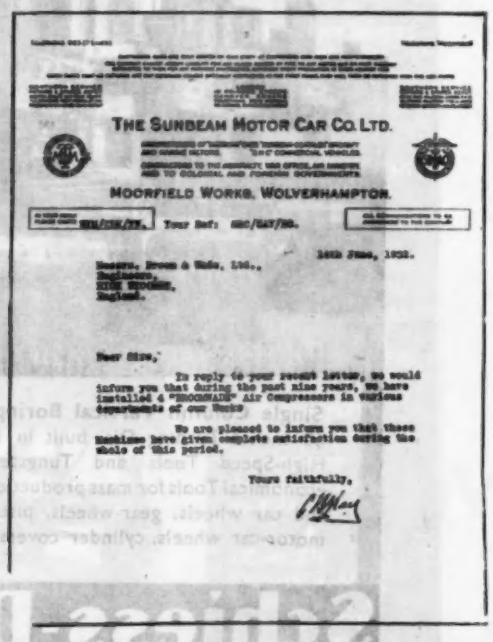
We are pleased to state that the machines in question have given complete satisfaction throughout their service, requiring performance and maintenance, and we have no objection to you making use of this information for the purpose of advertisement.

Yours faithfully,
ROLLS-ROYCE LIMITED

TWO FAMOUS MOTOR CAR MANUFACTURERS TESTIFY TO THEIR

## HIGH EFFICIENCY and LASTING RELIABILITY.

Capacities from 5 to 5,000 c. ft. free air per minute. Any pressure, any type of drive.



THE SUNBEAM MOTOR CAR CO. LTD.
MOORFIELD WORKS, WOLVERHAMPTON.

Messrs. Broom & Wade, Ltd.,
England.

Dear Sirs,

We are pleased to inform you that these Machines have given complete satisfaction during the whole of this period.

Yours faithfully,

We solicit your enquiries.

Literature and particulars sent upon request.

**BROOM & WADE LTD.**

**HIGH WYCOMBE BUCKS.**

# Cheapest Electricity — without Noise, Vibration or Trouble — by installing

## CROSSLEY Compressorless DIESEL ENGINES

At the
**MARBLE ARCH PAVILION**
Silently, Smoothly, this CROSSLEY DIESEL provides trouble-free reliable power.

Vertical types are built in 2 to 6 cylinder units, from 75 to 450 B.H.P. Horizontal types from 5 to 1000 B.H.P.

Doubts as to the advisability of installing an internal combustion engine in a thickly populated area can be dispelled by perusal of the facts given below.

Here is a Crossley 80 K.W. Diesel electric set installed in the very heart of one of the world's most exclusive residential areas, where any noise, vibration, or other nuisance, would be a serious matter. Situated in the West End of London, adjoining Park Lane, the Marble Arch Pavilion is one of the finest cinemas in the land and possesses most lavish equipment.

This Crossley generating set supplies trouble-free power for the whole of the cinema, including lighting, projectors, café and exterior illumination. Its steady output, the simplicity of its controls, and the absence of vibration and noise, are prominent features.

**ELECTRICITY at less than — ½ penny per unit — TOTAL ALL IN COST.**

D. 28

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**Particulars of Sturtevant Heating Systems are given in our publication E. 1124.**

Sturtevant plant is of British Manufacture throughout.

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# "VEEFLAT" DRIVE

**AVOID**

**Belt Slip, Belt Guards, Stoppages, Oily Chains, and Chain Cases, noise and dust, and have no transmission trouble.**

**With a ratio of not less than 3 to 1, Smith's "Veeflat" drive eliminates the expensive "V" grooved driven Pulley, an ordinary Flat Face Pulley is all that is necessary.**

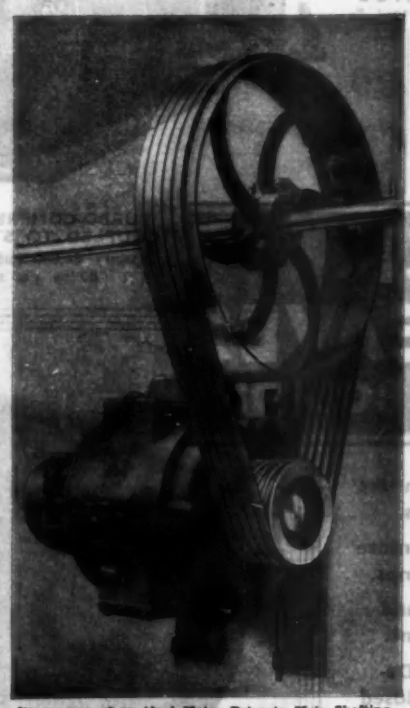

Illustration of an ideal Motor Drive to Main Shafting.

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*Engineers and Ironfounders,*
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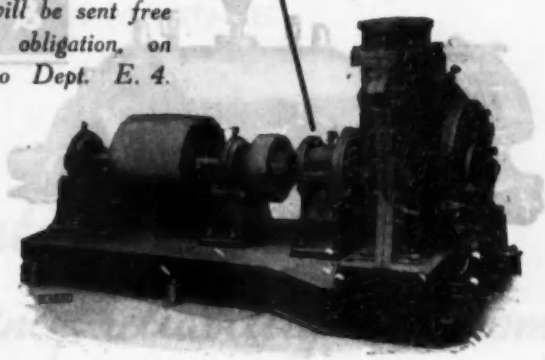
ROBUSTON PUMP

This new catalogue contains many illustrations and particulars of the RoBuston Pump for gravel, china clay, tin and other water-logged solids.

A copy should be in the files of every official concerned for the pumping of solids.

*Your copy will be sent free and without obligation, on application to Dept. E. 4.*

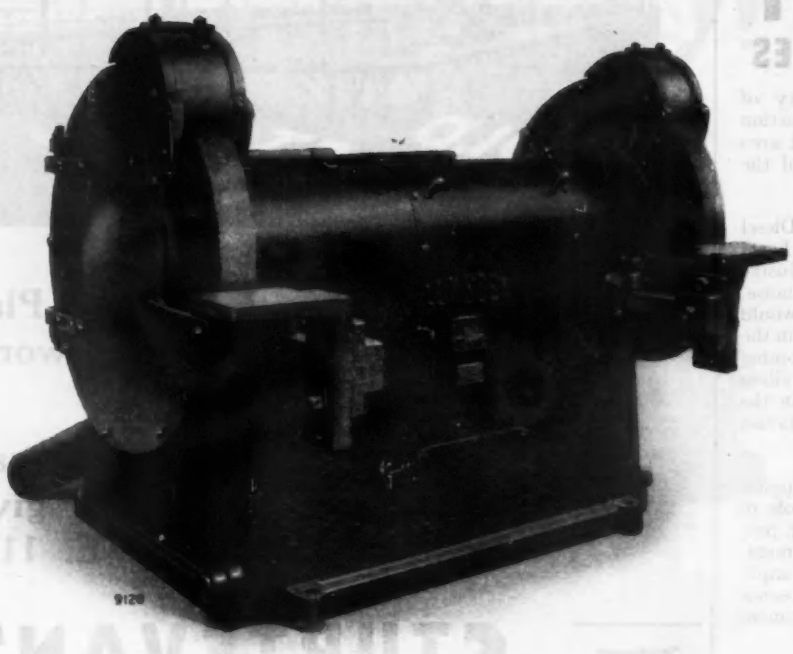


**RUSTON-BUCYRUS LTD**
**Lincoln England**

# HERBERT

## 9000 FEET PER MINUTE

**WITH PERFECT SAFETY.**



IF you install this Lumsden High-Speed Floor Grinder equipped with Grinding Wheels made by the Norton Grinding Wheel Co., Ltd., at Welwyn Garden City, you can maintain a surface speed of 9000 ft. per minute **with perfect safety.**

The equipment is **specially designed** to withstand the strain of this high speed.

You will reduce your labour costs by 60% as many other satisfied users have done.

Machines and wheels can be delivered from stock.

DEMONSTRATIONS ARRANGED BY APPOINTMENT.

**Capacity 30" × 4" wheels.**

## ALFRED HERBERT LTD. COVENTRY.

*Write for full particulars of:*

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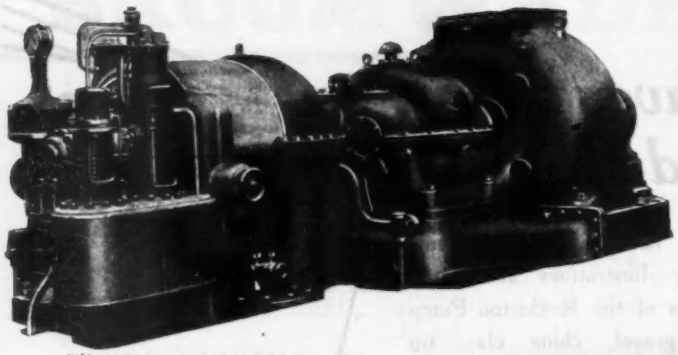
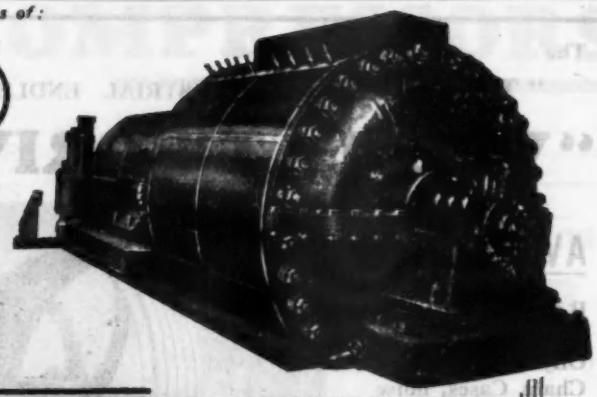
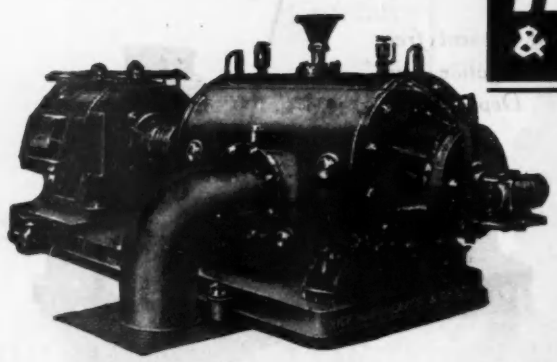


**STEAM TURBINE . . . .**
650 k.w. Steam Turbo-Alternator arranged to pass out Steam for Process Work.



**TURBO-COMPRESSOR DIRECT COUPLED TO STEAM TURBINE**
Capacity 24,000 cubic feet. Pressure 80 lbs. per square inch.

## HICK HARGREAVES & CO. LTD. BOLTON



**ROTARY COMPRESSOR . . . .**
Capacity from 15/6,000 cub. ft. per minute.
Pressure 1/150 lbs. per sq. inch.
Highest Efficiency, Automatic Control.

**"Hivac" Steam Jet Air Ejectors.**

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**Evaporators and Distilling Plant.**

**Feed Water De-Aerators and Closed Feed Systems.**

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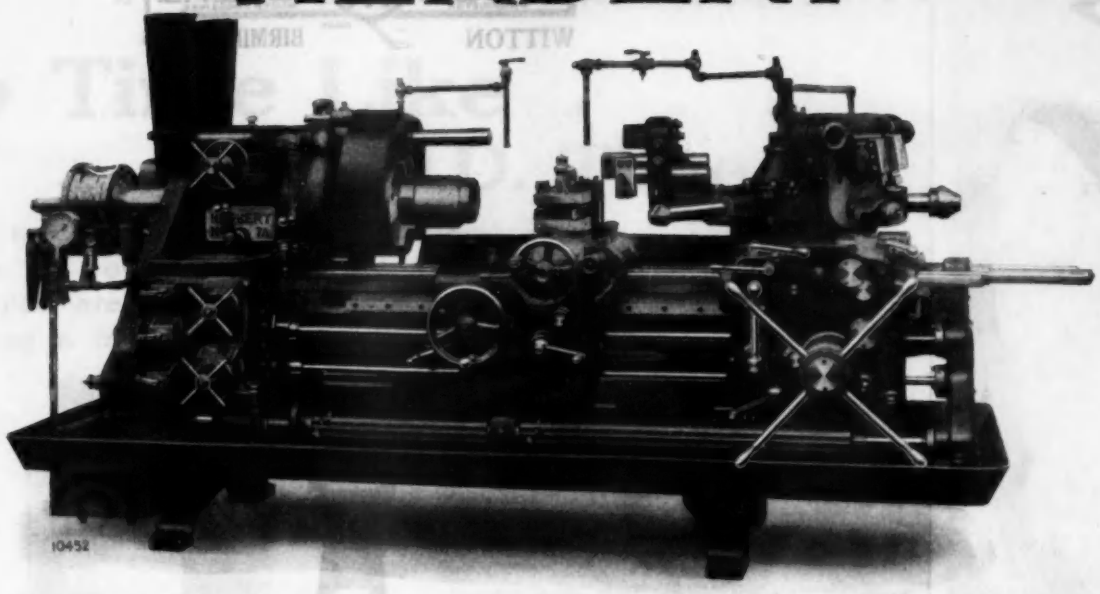
**STEAM CONDENSING PLANT . .**
Surface Condensing Plants supplied up to all capacities for the smallest and largest plants.

# HERBERT



Herbert No. 7A Combination Turret Lathe with patent prismatic covered bed, anti-friction bearings to spindle and all shafts. Automatic lubrication. 15¼" swing.

## BEST BY TEST.

THE new Herbert No. 7A Combination Turret Lathe has just been through its tests. Using a single Ardoloy Tipped Tool the following result has been obtained in Cast-iron, 198 Brinell.

| Reduction in diameter. | Cutting speed. | Feed. | Material removed per min. |
|---|---|---|---|
| 1in. ... | 580ft. per min. ... | 25 cuts per in. ... | 132 cu. ins. |

Equip your plant for the tungsten-carbide tool era—Ardoloy Tipped Tools and the new Herbert range of super Turret Lathes.

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DRAINAGE
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Among the SEWERAGE or WATER WORKS INSTALLATIONS completing or manufactured by Gwynnes lately are those for :—

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# HUMPHREYS
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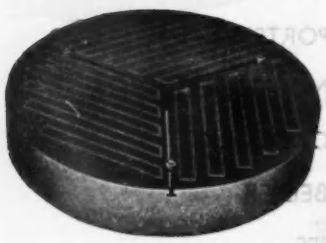

We make different types to suit different requirements.

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Our complete catalogue will be sent you on request.
WRITE NOW.

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HIGGS (HM) MOTORS
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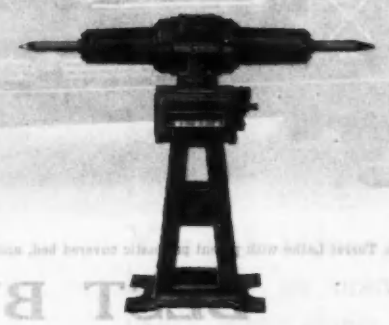

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A copy of Section 200 of our catalogue covering a range of the above machines will be sent to you on request.

GUARANTEED FOR EVER

Birmingham. Bristol. Cardiff. Edinburgh. Glasgow. Leeds. Liverpool. London. Manchester. Newcastle. Nottingham. Peterborough. Sheffield.

# 7,000 SATISFIED USERS
Because they are Accurate and Dependable (Faces are ground to half a thous.)
and Deliveries are Certain

FIT STANDARD'S

Standard's cast iron, hammered piston rings are backed by 40 years' specialized experience — ensuring just those qualities of dependability, accuracy and long life which discriminating engineers appreciate.

*They never let you down!*

**And be insured against all risks**

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ASSOCIATED BRITISH MACHINE TOOL MAKERS LTD.

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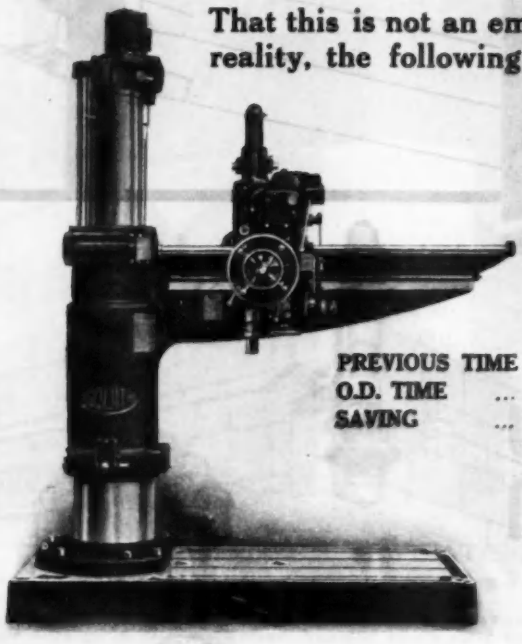
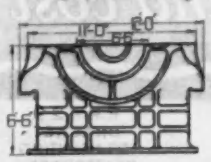
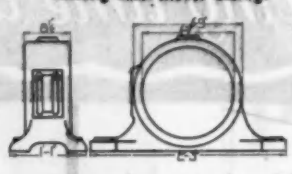
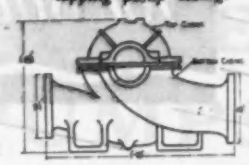
# No Time Like . . . . . the O.D. Time!

**Now a recognised standard in drilling practice. If your times are not O.D. Times you are out of date—definitely neglecting a most important economy.**

**That this is not an empty claim, but a stark reality, the following figures will prove:—**



| | Drilling, tapping and facing turbine casing. | Drilling, facing, tapping and countersinking steel motor casing. | Drilling, facing and tapping pump casing. |
|---|---|---|---|
| |  |  |  |
| PREVIOUS TIME ... | 28½ hours | 1 hr. 45 mins. | 3 hrs. 5 mins. |
| O.D. TIME ... | 22½ hours | 45 mins. | 2 hrs. 15 mins. |
| SAVING ... | 6 hours | 1 hr. | 50 mins. |

*Above are a few comparisons which have recently come to our notice—all based on the same setting arrangement. Multiple setting has in many cases enabled such rates of output to be trebled.*

**High speed, Time-saving, Power-saving, Efficiency-compelling—The ASQUITH O.D. Type Super-Electric Radial Drills with "15 x 23" Concentrated Control. Full details on request—or better still, call for a demonstration at any time in our Works.**

**"Antiquates all previous conceptions of high speed drilling."**

A further aid to Drilling Economy—**"BETTER-SERVICE" Sockets.** Write for sample.

## WILLIAM ASQUITH LTD., HALIFAX.

# "BUTLER" PUNCHER SLOTTERS

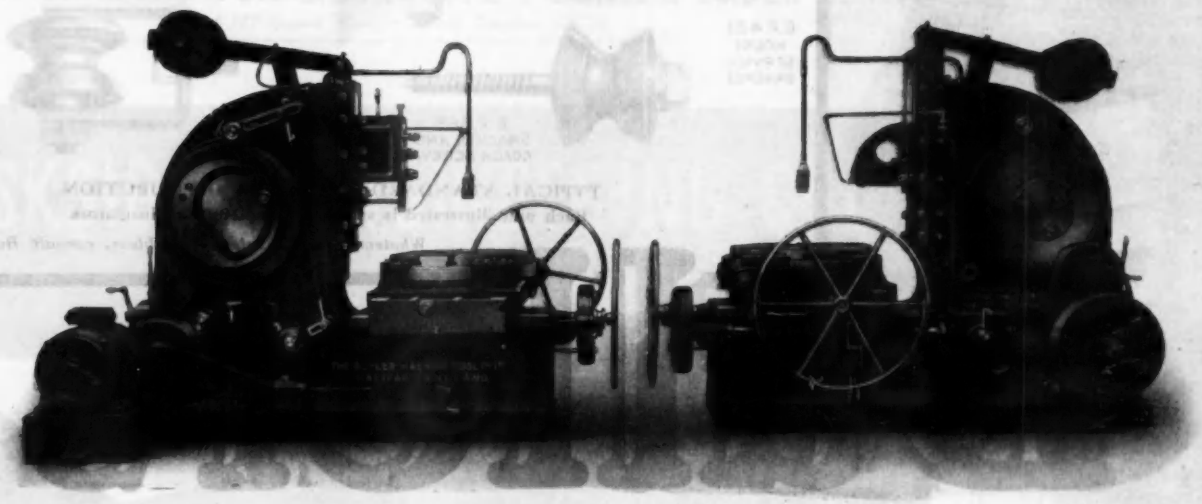


**Illustration shows Two 12½" stroke "Butler" Puncher Slotters. The special features include motor drive, pendant push-button control, special toolholders, built-in circular tables, special large hand wheels for profiling, pump lubrication, etc. Sizes made 10" to 48" stroke.**

Phone: No. 3711 (Two Lines).

## THE BUTLER MACHINE TOOL COMPANY LTD.

VICTORIA IRONWORKS, HALIFAX.

Wires: "Butler Halifax."

# Distribution Equipment

## Bullers

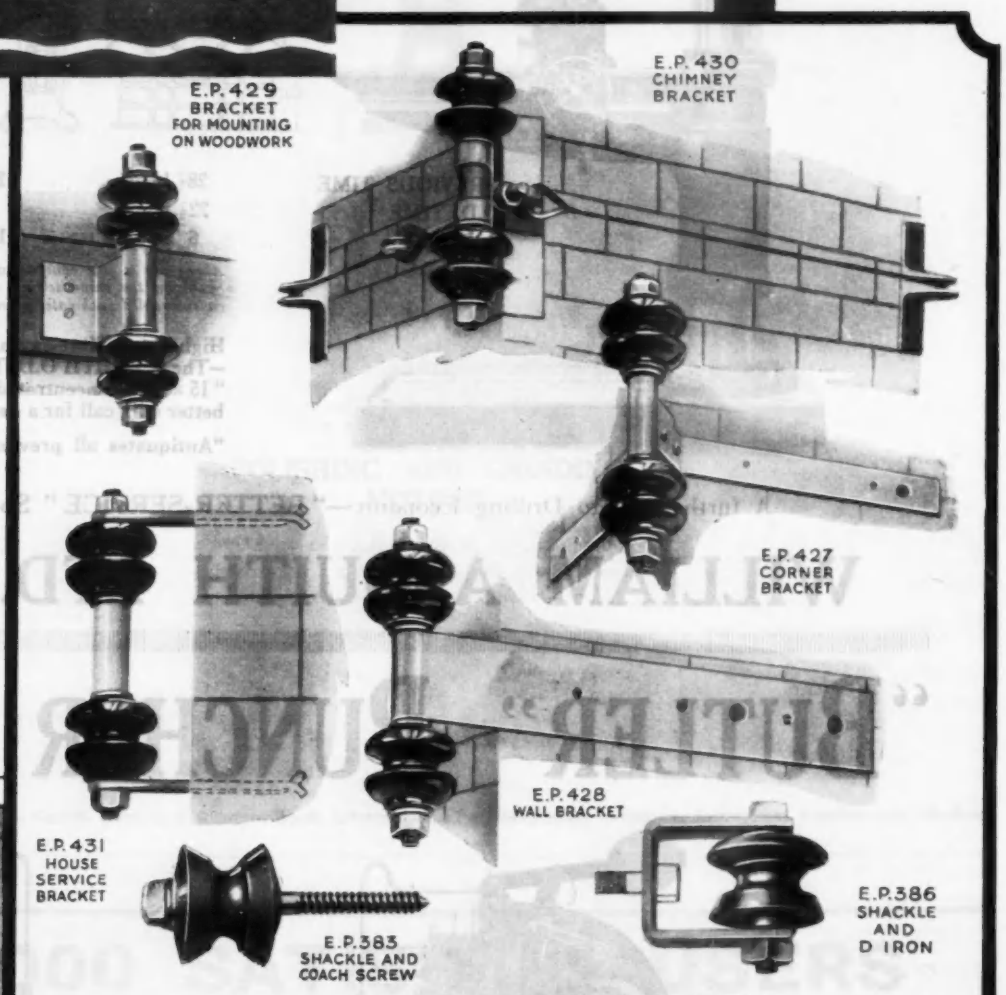
### STANDARD ADAPTABLE UNITS

*For Saving time and cost*

STANDARD ranges of Insulators and Metal Fittings forming adaptable units for Overhead Distribution are designed and manufactured throughout by Bullers at their own Works.

Stocks of standard designs are maintained and we offer unequalled service in the production of every type of line equipment.

We shall be glad to receive enquiries and submit estimates to meet any specification.


E.P.429 BRACKET FOR MOUNTING ON WOODWORK
E.P.430 CHIMNEY BRACKET
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E.P.428 WALL BRACKET
E.P.431 HOUSE SERVICE BRACKET
E.P.383 SHACKLE AND COACH SCREW
E.P.386 SHACKLE AND D IRON

TYPICAL STANDARD UNITS FOR DISTRIBUTION.
Each unit illustrated is supplied complete with insulators.

*Whatever your insulating problem, consult Bullers.*

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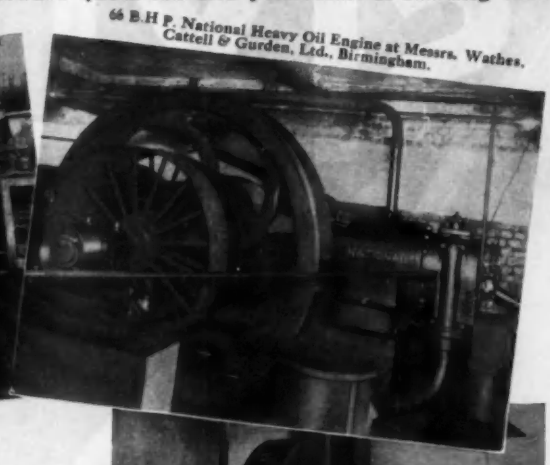
# "NATIONAL" ECONOMY

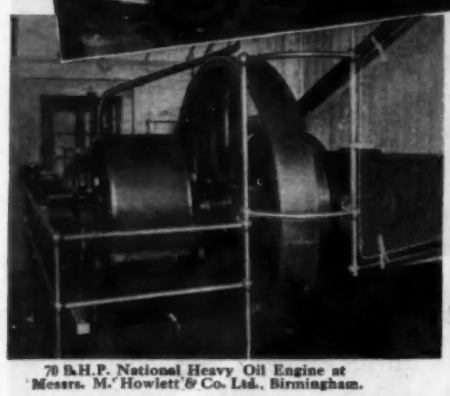
**In and around Birmingham may be found National Heavy Oil Engines in all classes of industry, and everywhere there is the same enthusiastic praise of their reliability and economy.**

**If you are paying more than ½d. per unit for electricity a National Oil Engine would be a profitable investment. Please allow us to forward quotation and particulars of running costs.**

55 B.H.P. National Heavy Oil Engine at Messrs. Beckett, Tyseley, Birmingham.

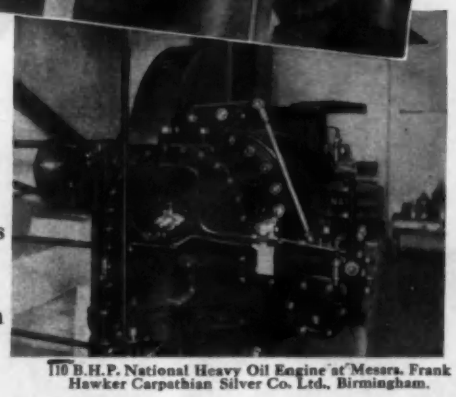


66 B.H.P. National Heavy Oil Engine at Messrs. Wathes, Cattell & Gurden, Ltd., Birmingham.



70 B.H.P. National Heavy Oil Engine at Messrs. M. Howlett & Co. Ltd., Birmingham.

Four typical National Heavy Oil installations in the City of Birmingham



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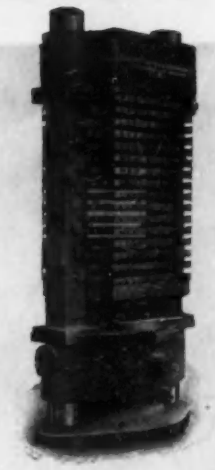

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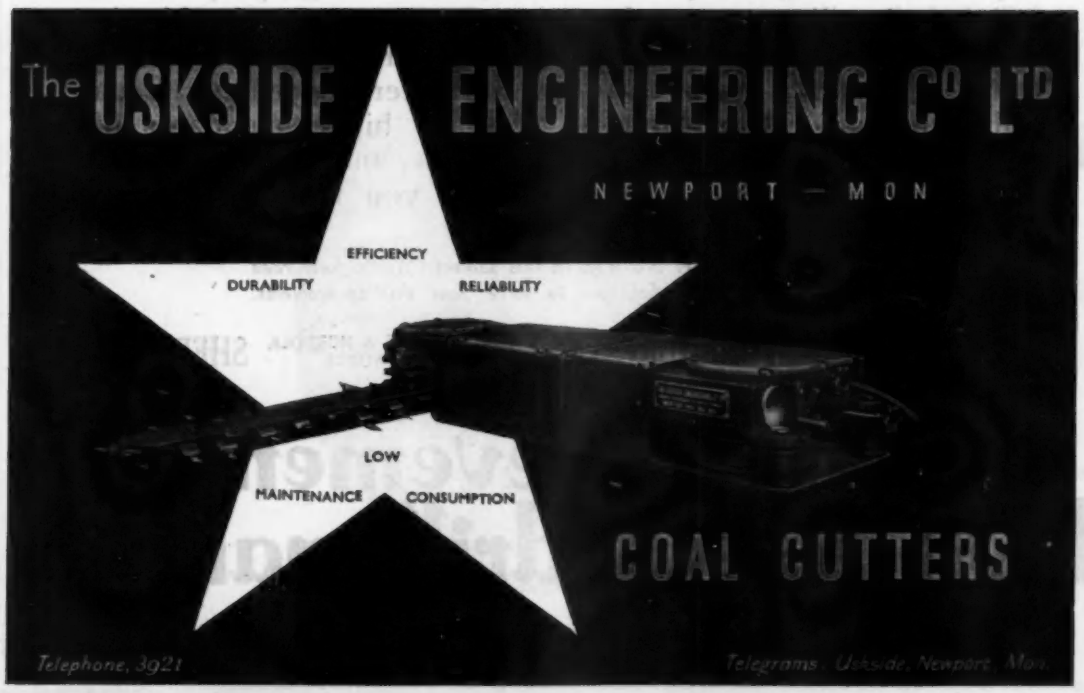




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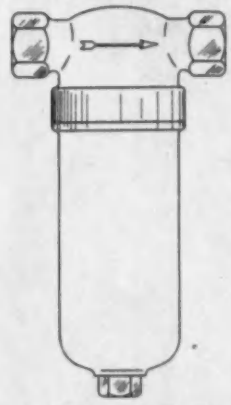

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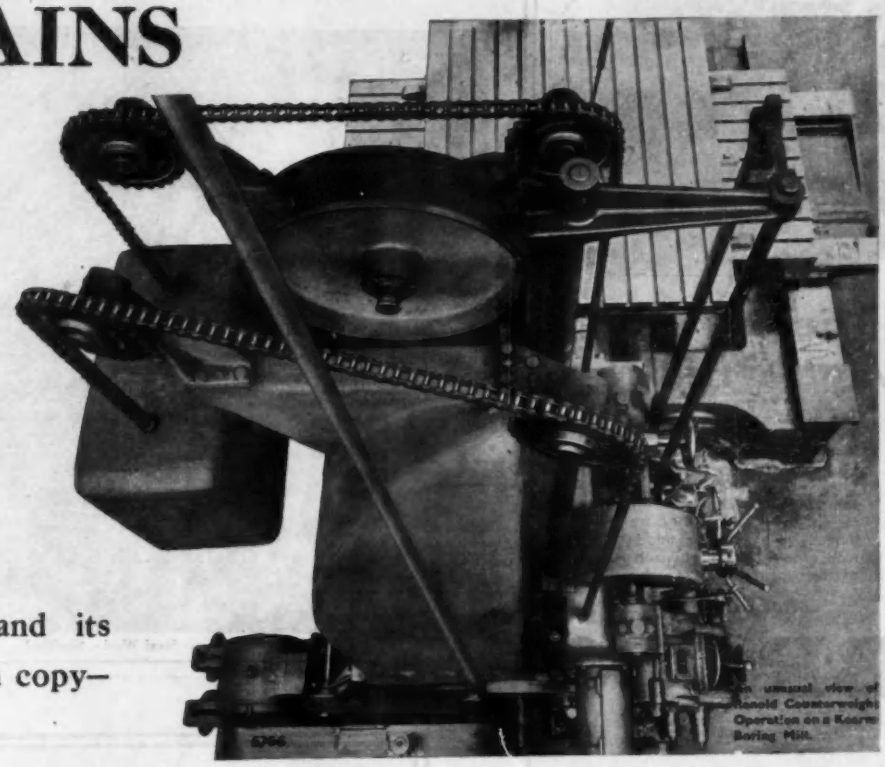

An unusual view of Renold Counterweight Operation on a Kearns Boring Mill.

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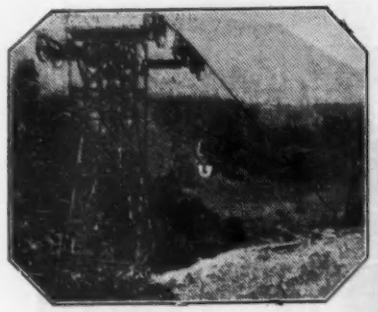

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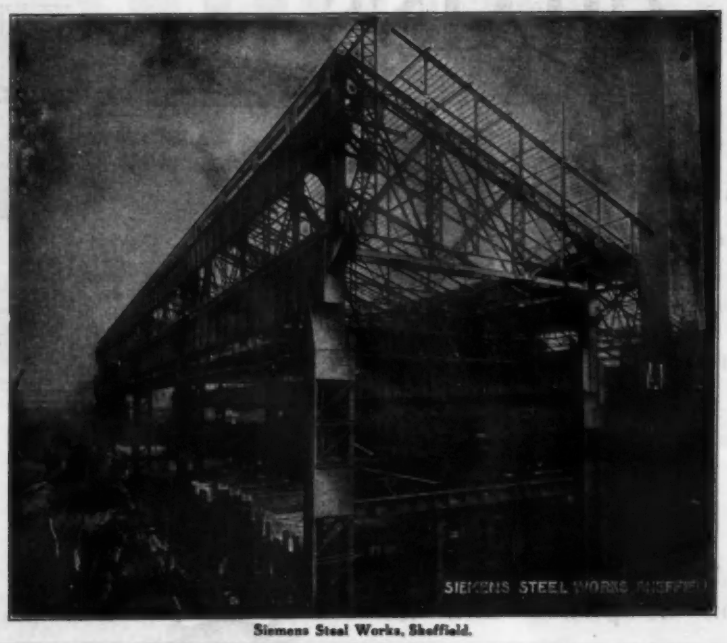

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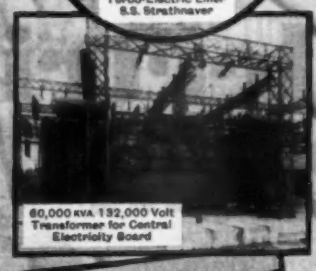

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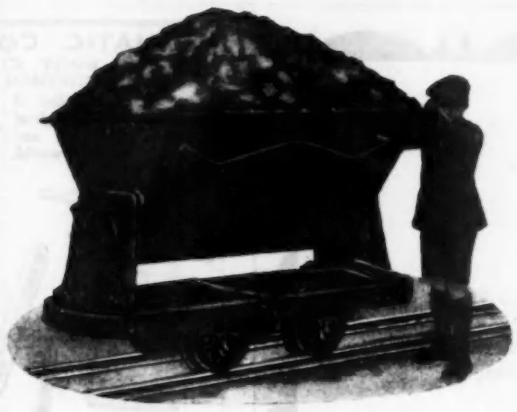

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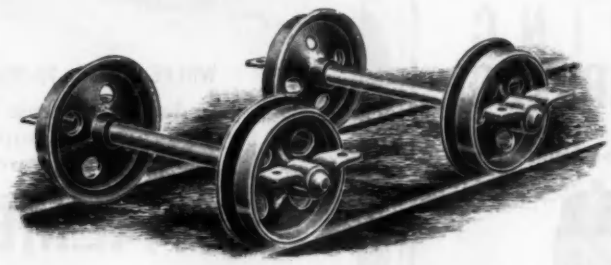

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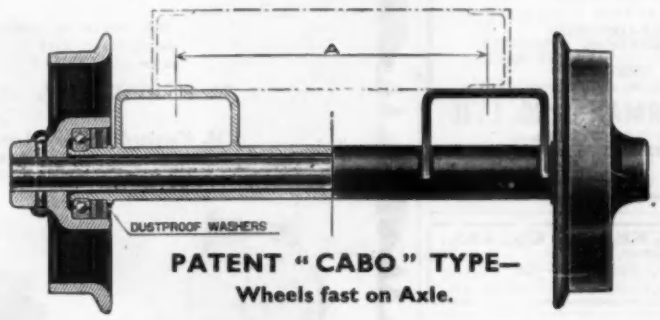


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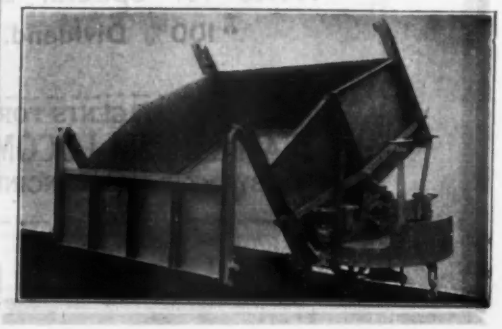

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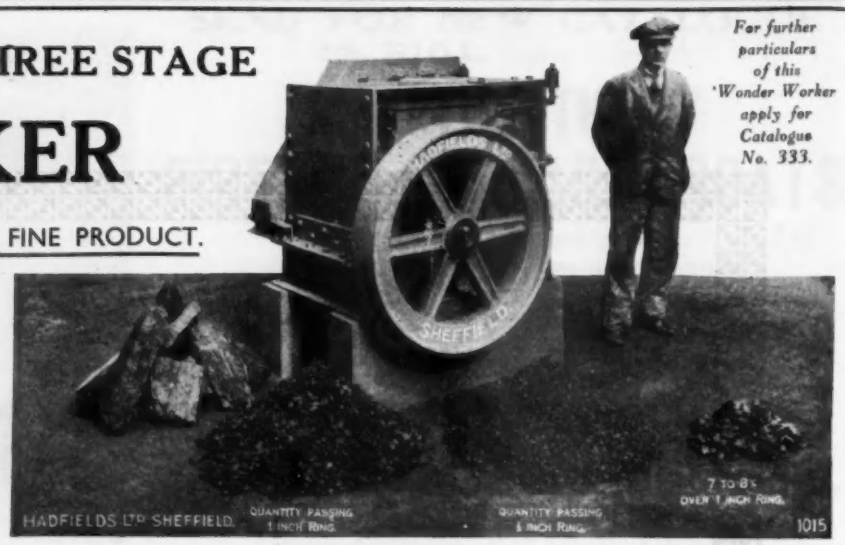


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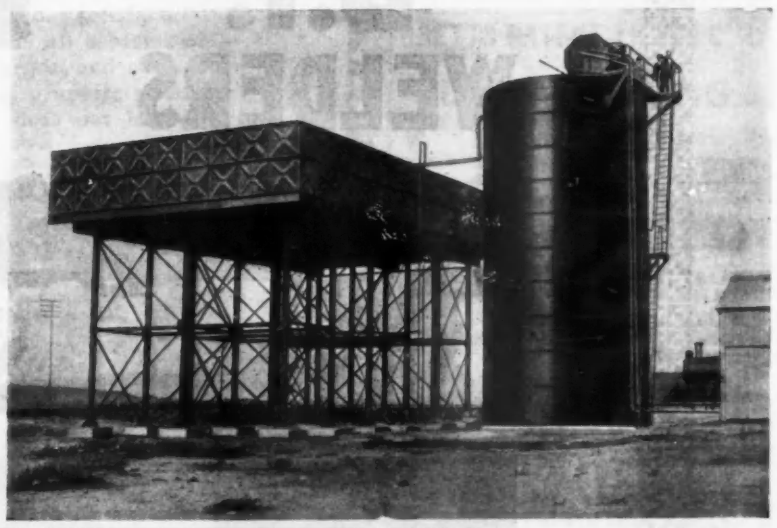

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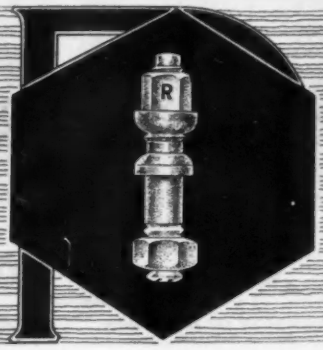

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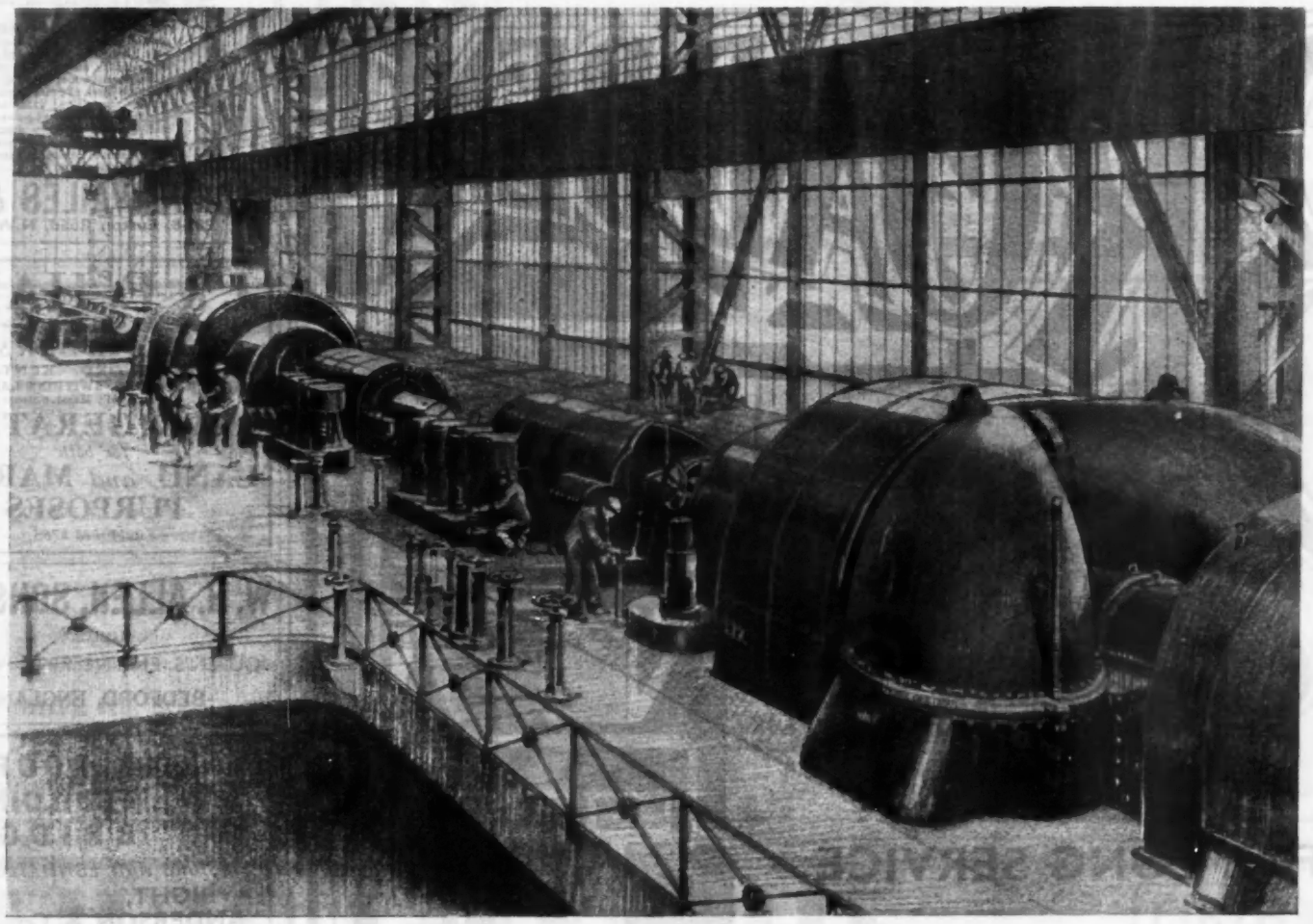

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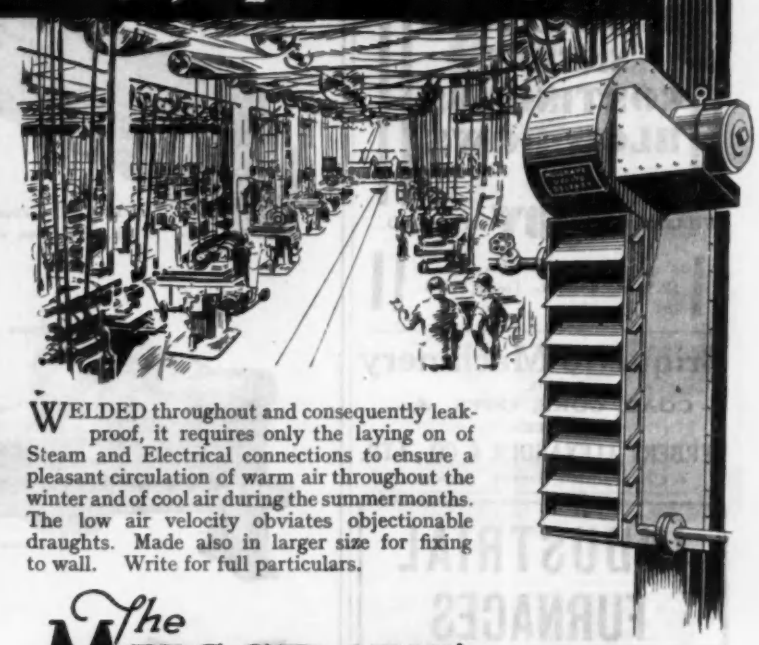

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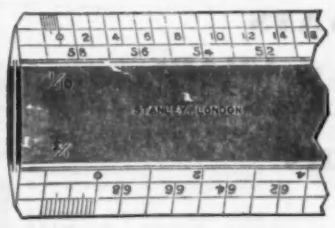

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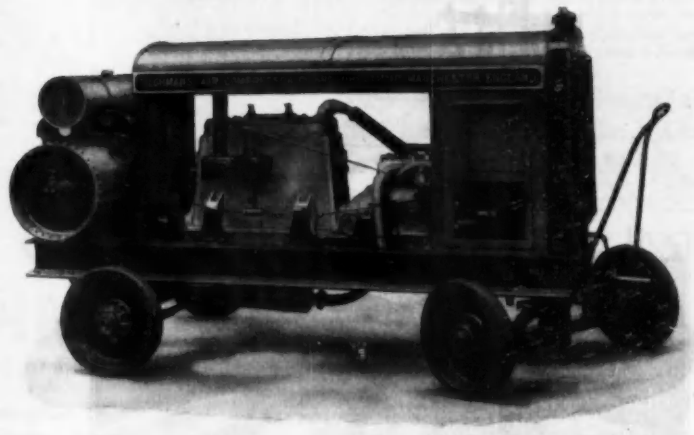

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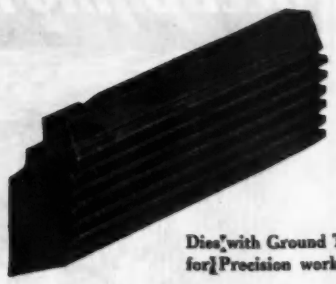

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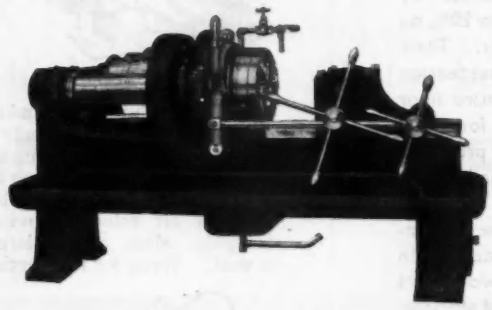

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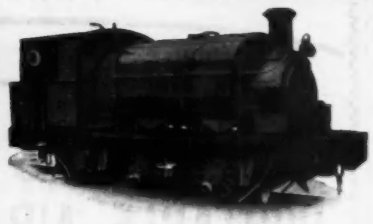

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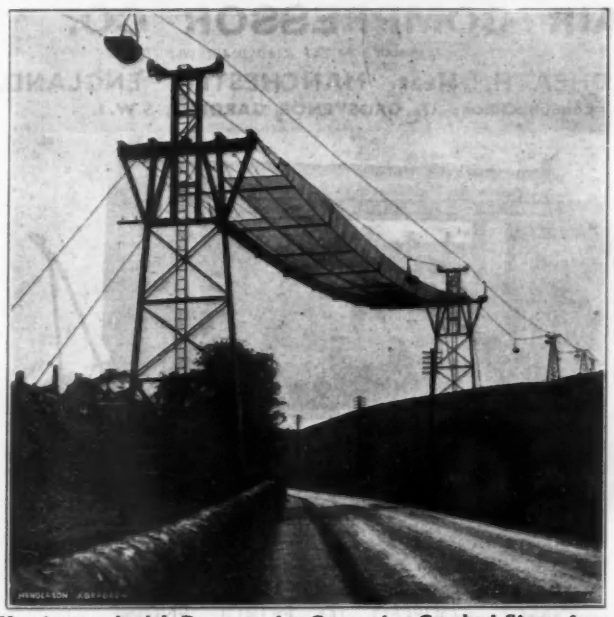

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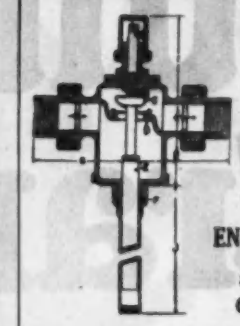

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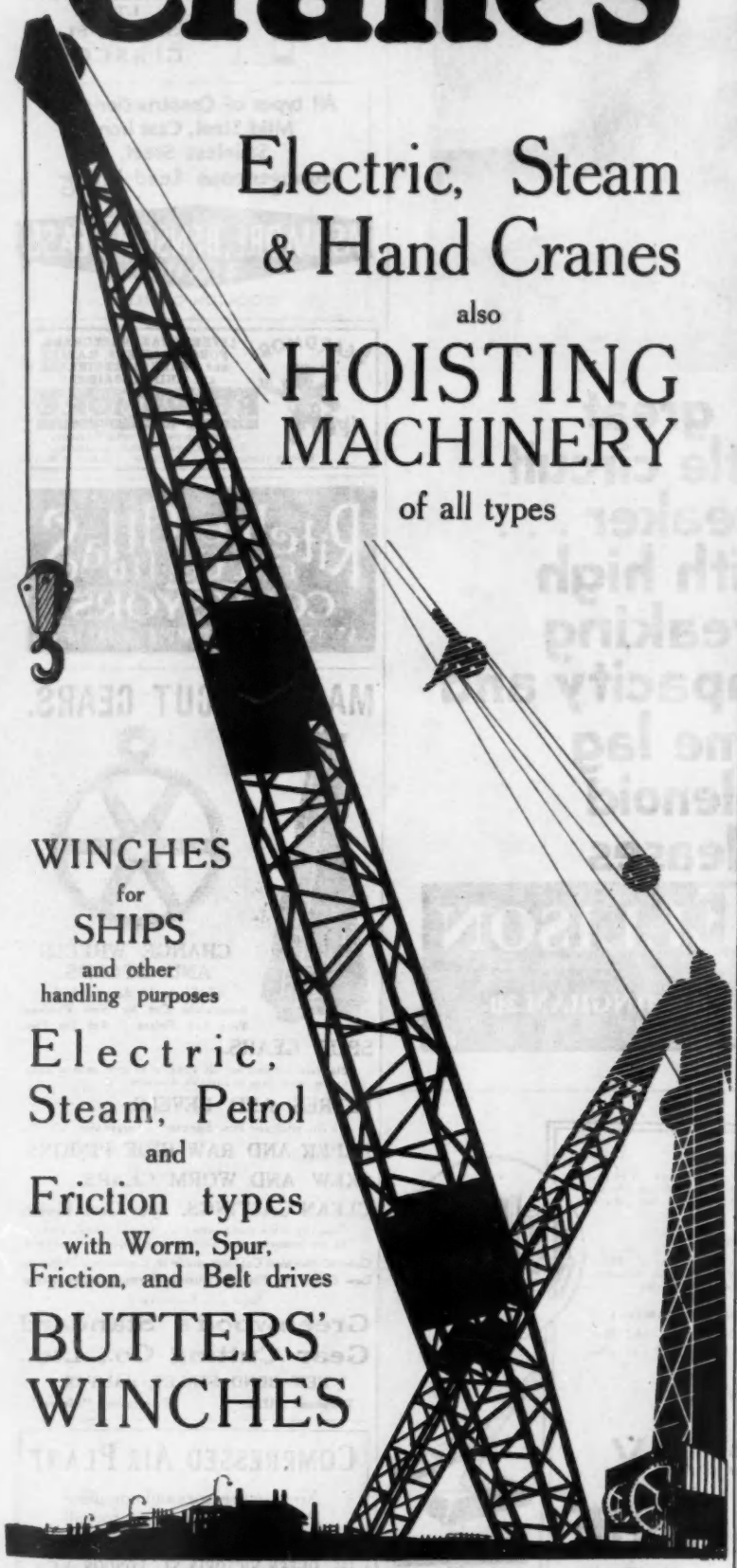

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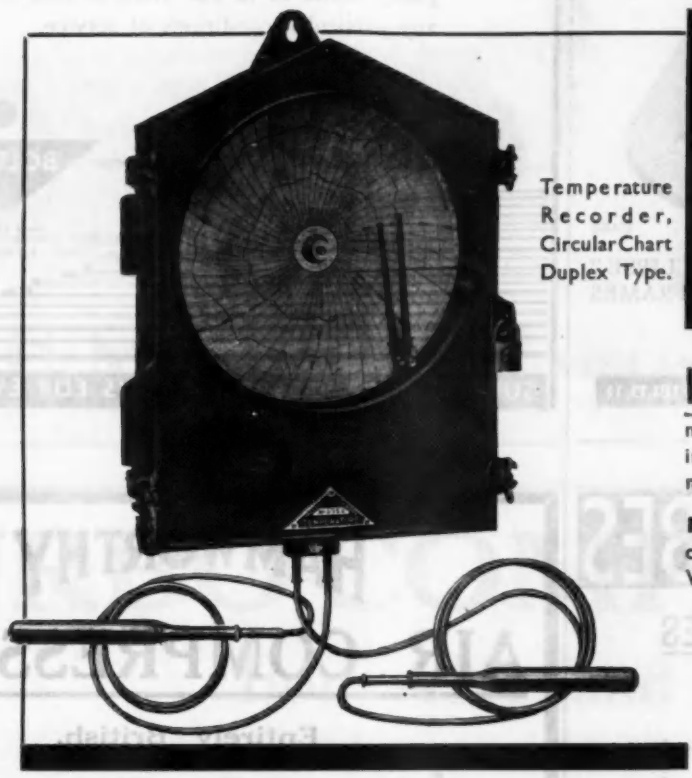

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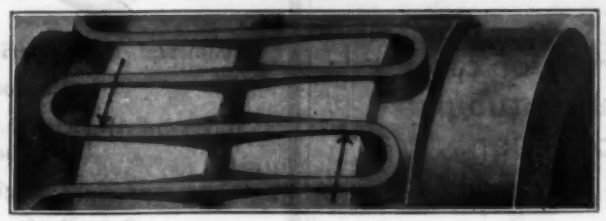

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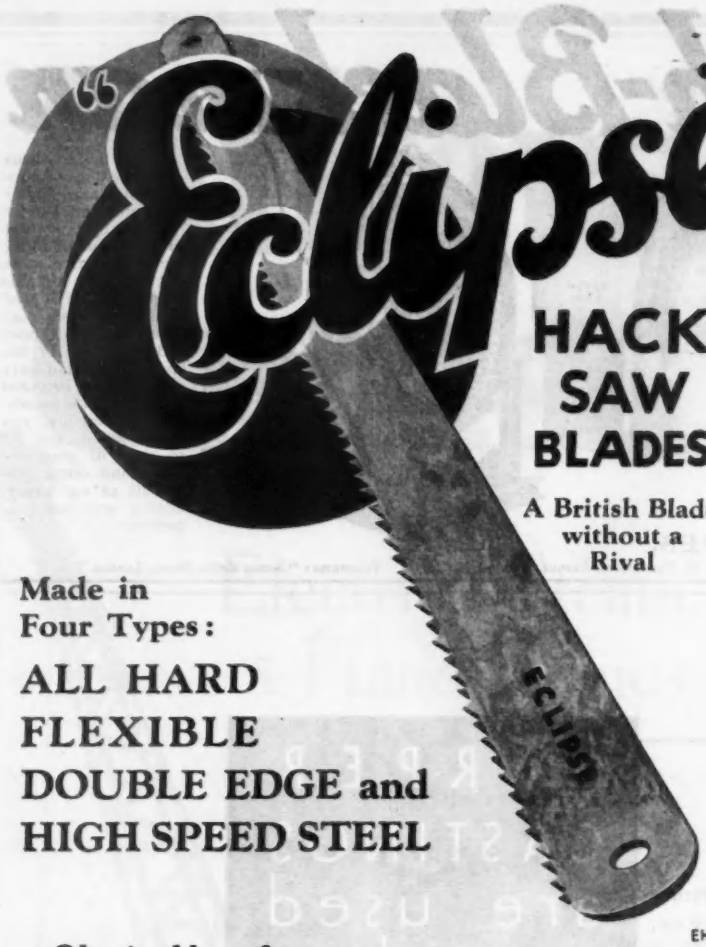


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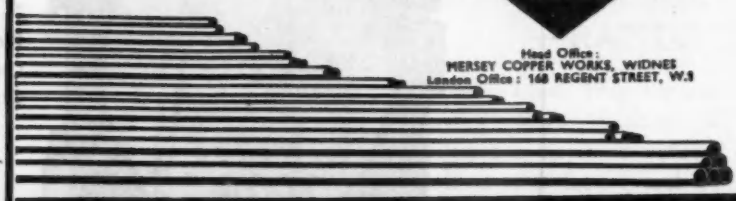

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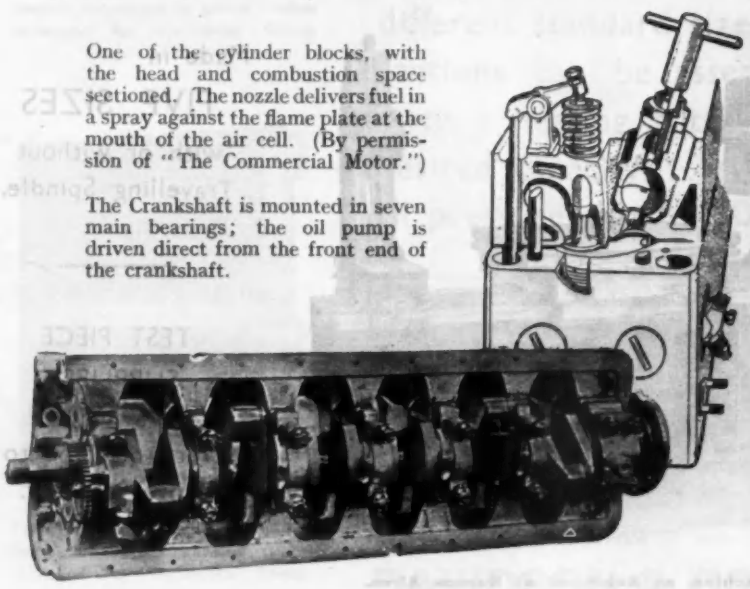

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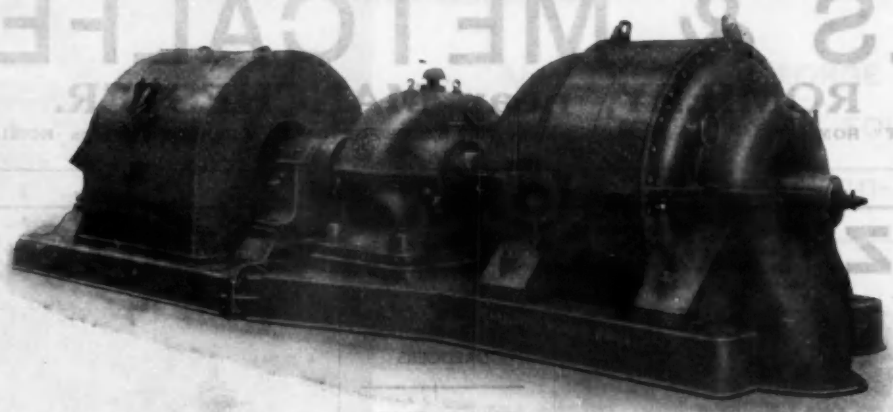

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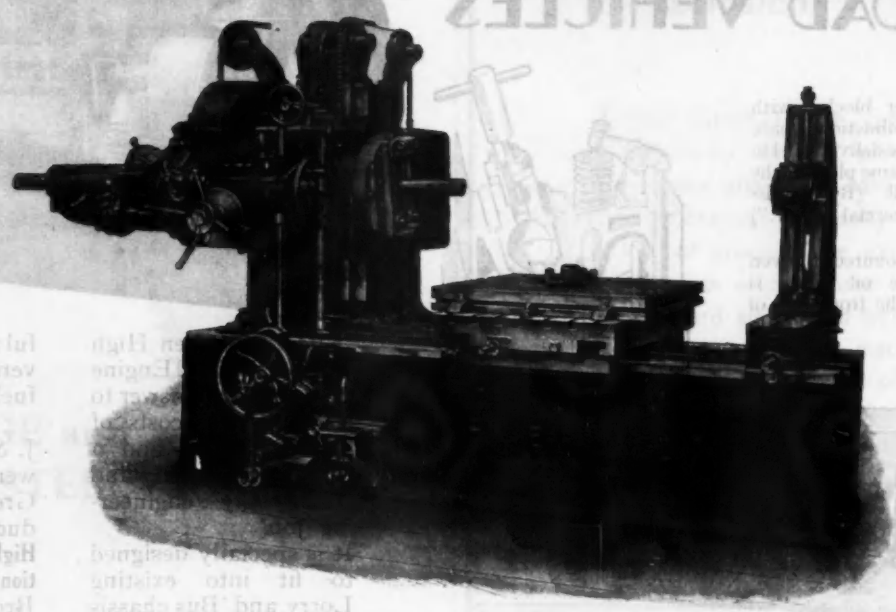

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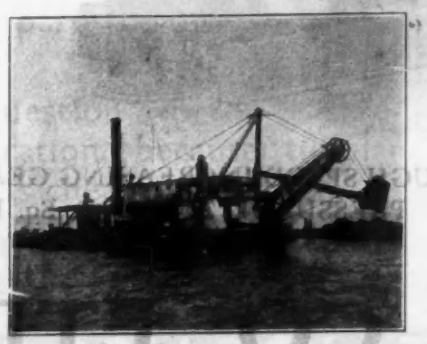

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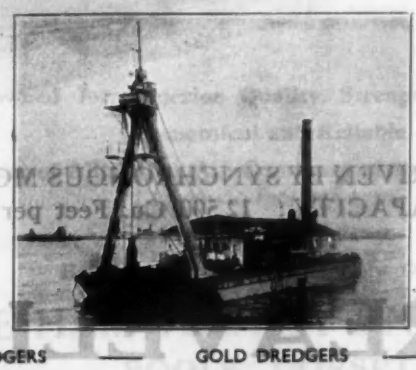

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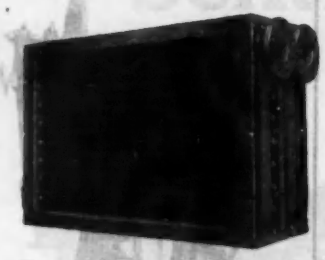

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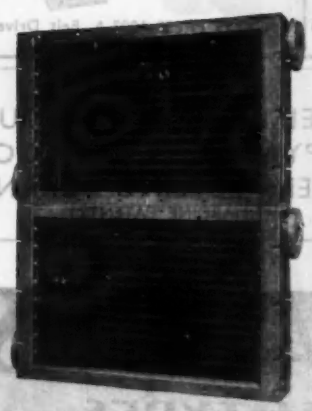

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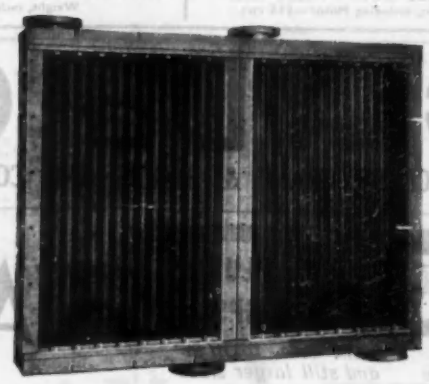

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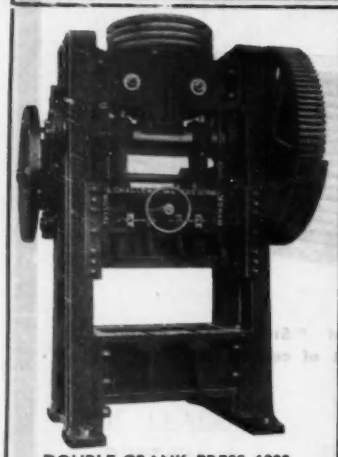

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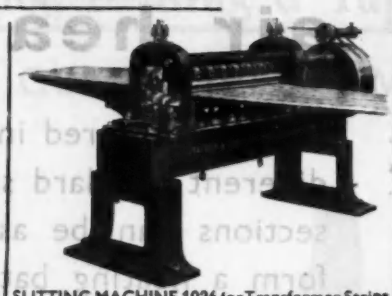

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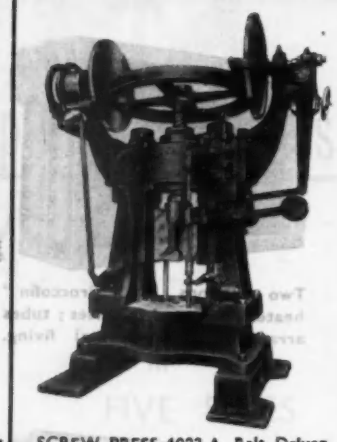

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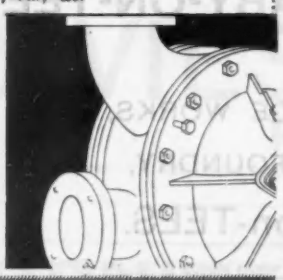

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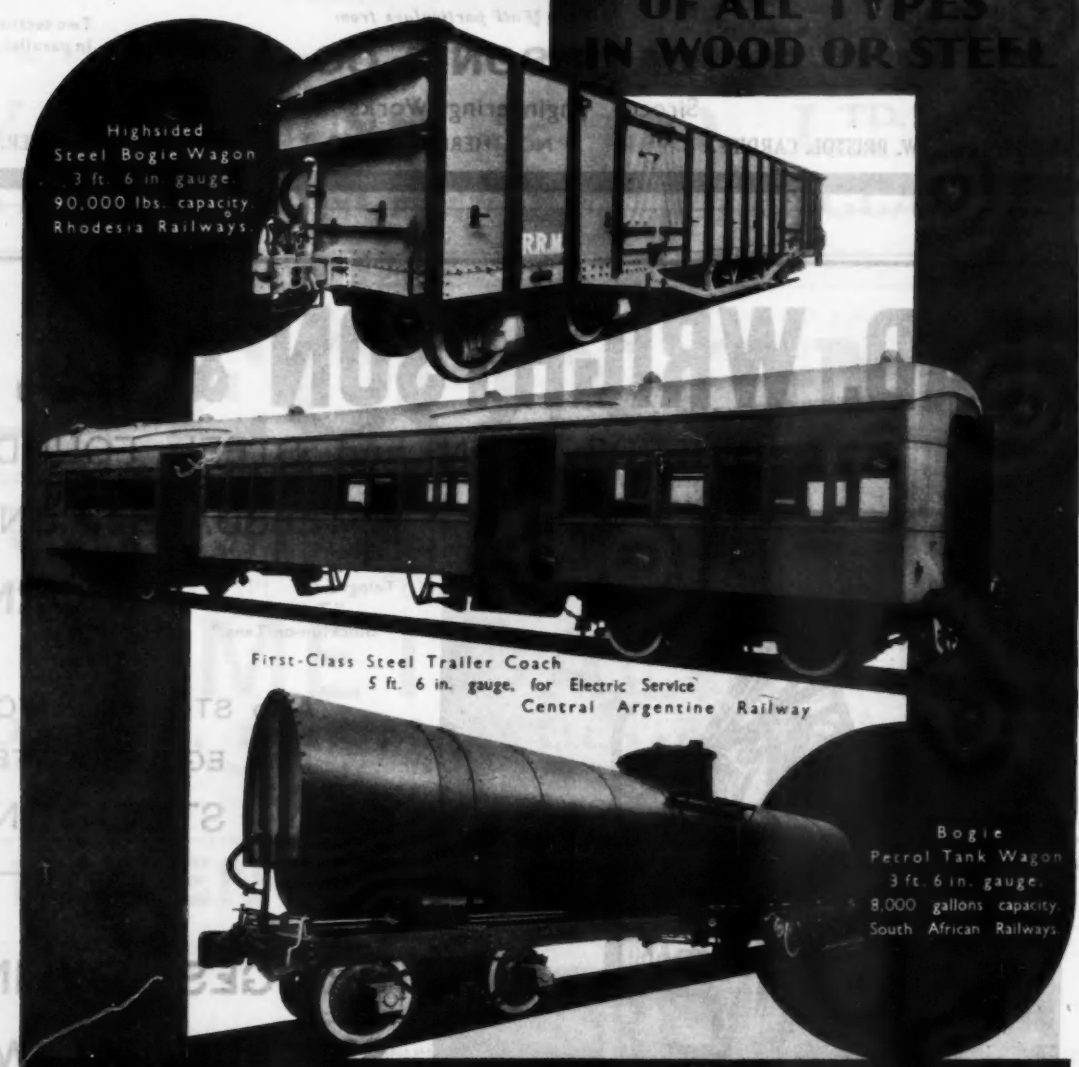

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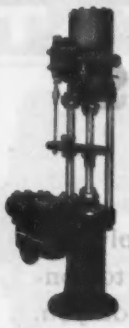

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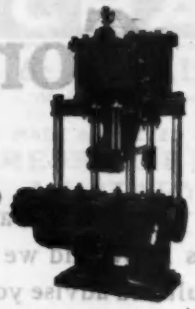

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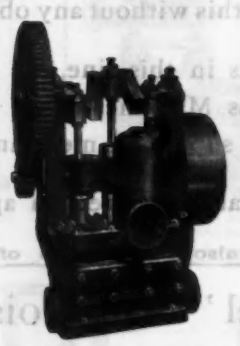

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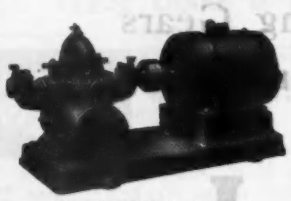

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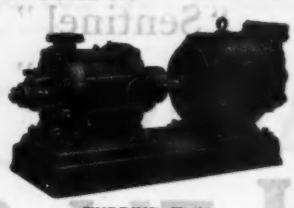

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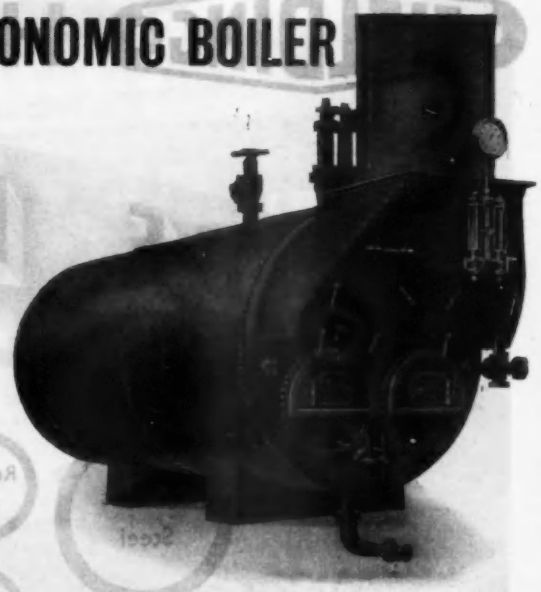

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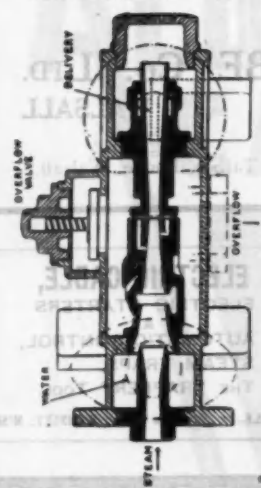


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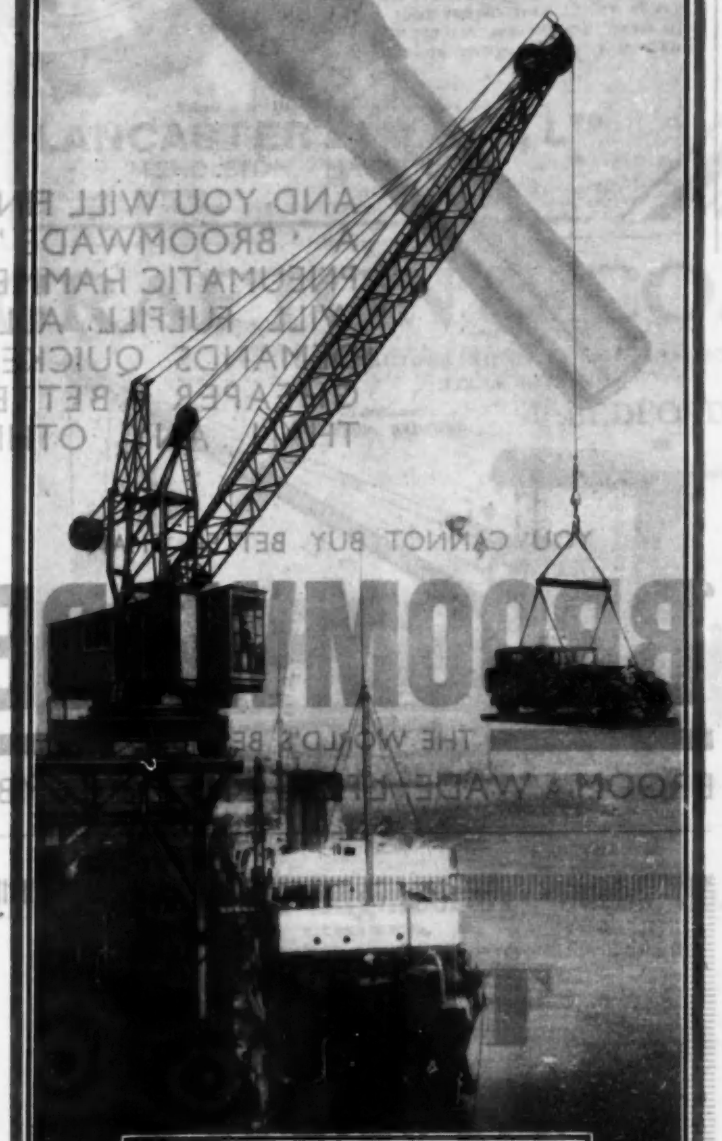

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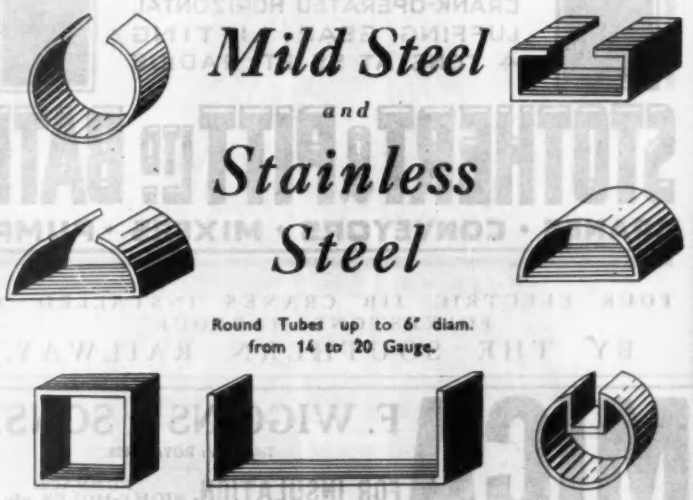

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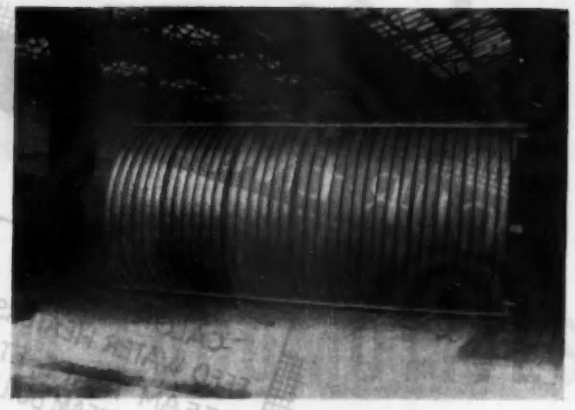

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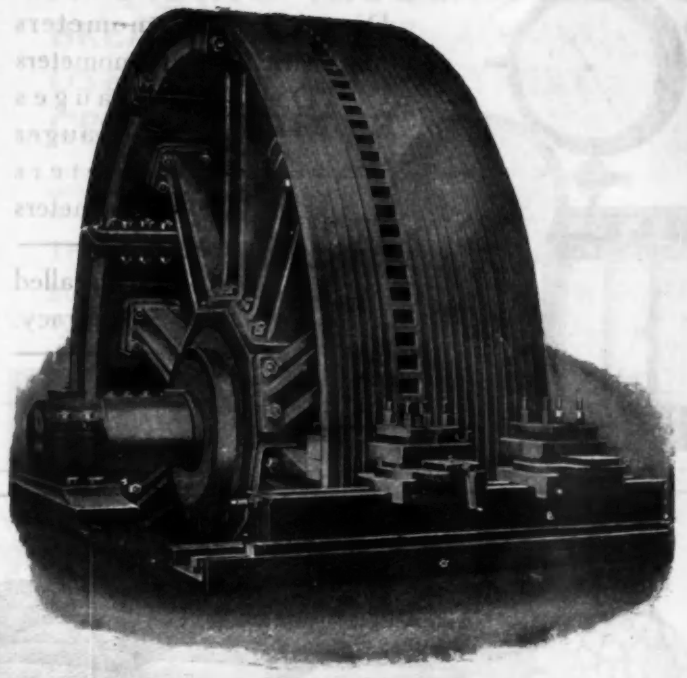

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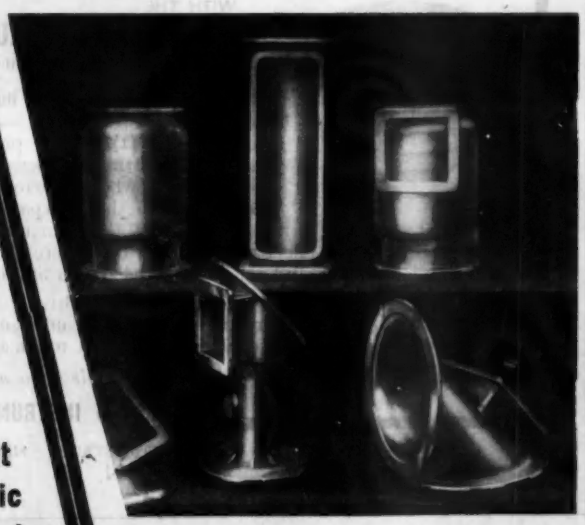

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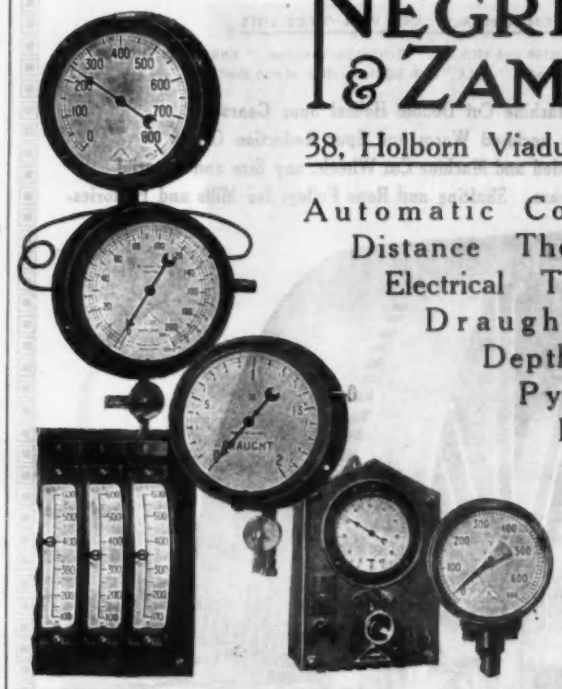

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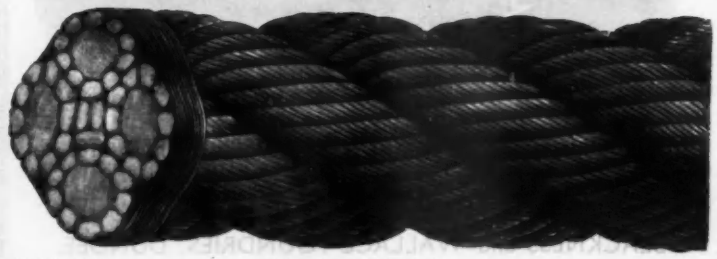

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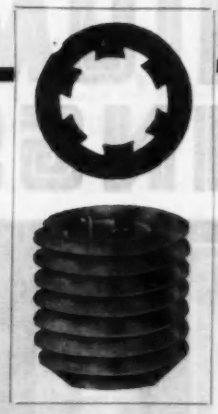

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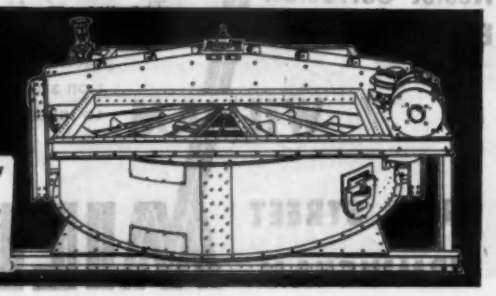

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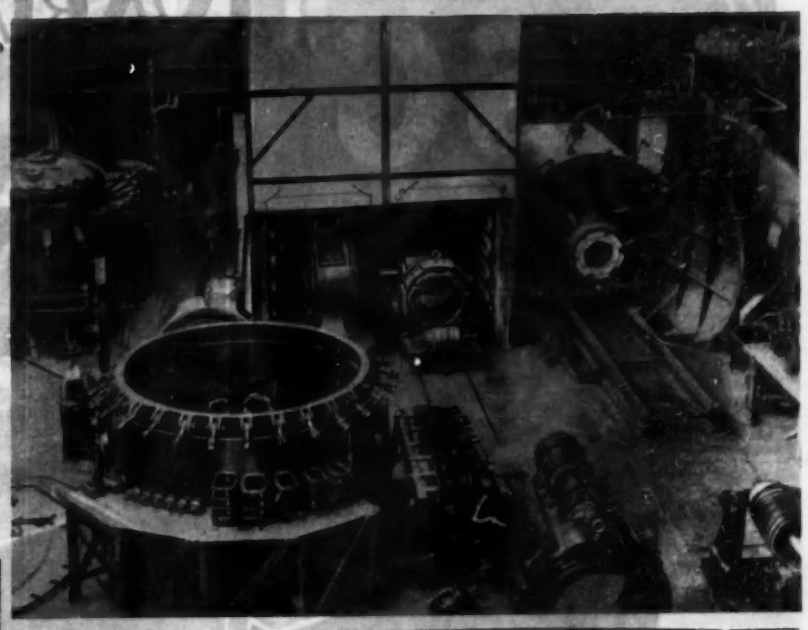

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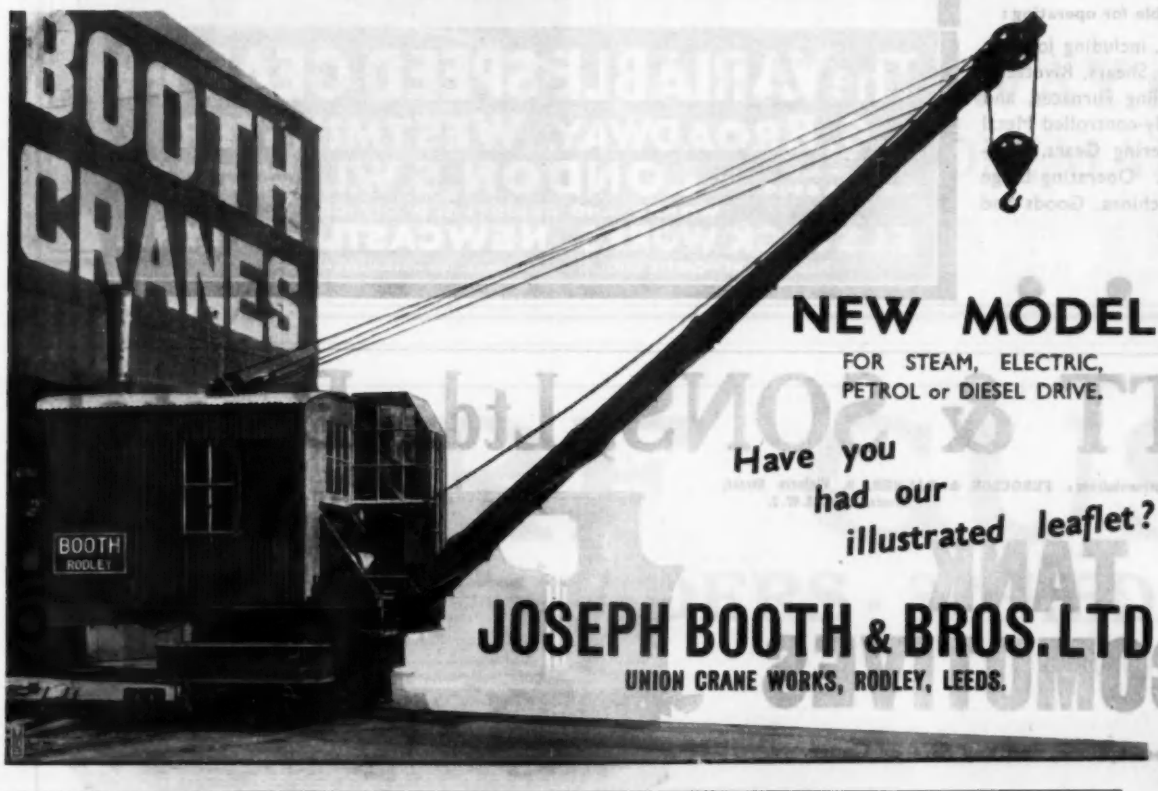


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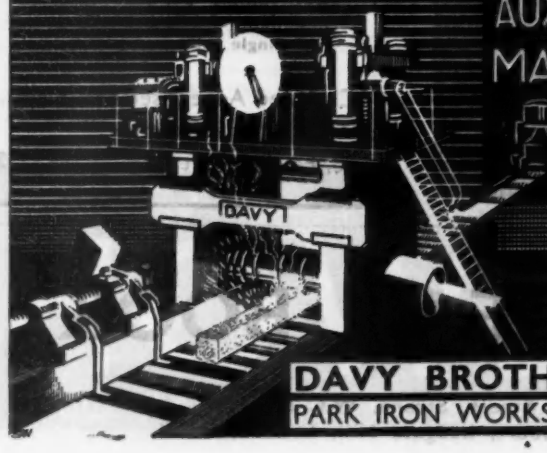


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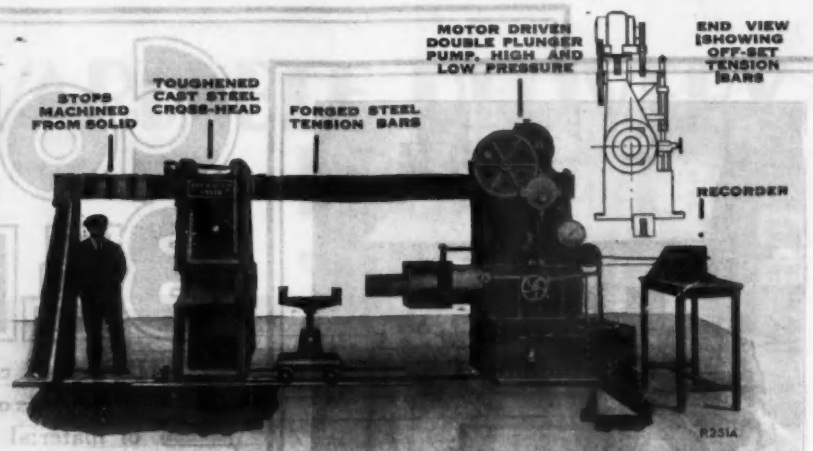
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| | PAGE |
|---|---|
| Abbott & Co., Ld. | 6 |
| Accles & Pollock, Ld. | 32 |
| Alexander, H., & Co., Ld. | 28 |
| Allen, W. H., Sons & Co., Ld. | 25 |
| Alley & Macllellan, Ld. | 37 |
| Arkinstall Bros., Ld. | 42 |
| Asbestos Cement Building Products, Ld. | 8 |
| Ash, J., & Son | 43 |
| Ashmore, Benson, Pease & Co., Ld. | 29 |
| Ashworth & Parker | 6 |
| Ashworth, Son & Co., Ld. | 6 |
| Asquith, W., Ld. | 15 |
| Associated British Machine Tool Makers, Ld. | 15 |
| Atlantic Engine Co. | 3 |
| Avonside Engine Co., Ld. | 38 |
| Bagnall, W. G., Ld. | 22 |
| Bailey, Sir W. H., & Co., Ld (cover) | iii |
| Bairnforth, T., & Co., Ld. | 39 |
| Barker, W. H., Ld. | 48 |
| Beardmore, W., & Co., Ld | 29 |
| Bennett & Sayer | 6 |
| Bennis, E., & Co., Ld (cover) | ii |
| Bettles & Sons | 30 |
| Boby, W., & Co., Ld. | 28 |
| Bolton, T., & Sons, Ld. | 32 |
| Booth, J., & Bros., Ld. | 43 |
| Boyle, Robt., & Son | 25 |
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| Broadbent, T., & Sons, Ld | 25 |
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| British Institute of Engineering Technology | 1 |
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| Bullers, Ld. | 16 |
| Butcher, H., & Co. | 48 |
| Butler Machine Tool Co., Ld | 15 |
| Butters Bros. & Co. | 30 |
| Churchill, C., & Co., Ld. | 4 |
| Clarkson | 48 |
| Clayton, Son & Co., Ld (cover) | iv |
| Cleveland Bridge & Eng. Co. | 20 |
| Clews Petersen Piston Ring & Engineering Co., Ld. | 14 |
| Clyde Crane & Eng. Co., Ld | 36 |
| Clyde Structural Iron Co., Ld | 6 |
| Clyne Engineering Co., Ld | 47 |
| Cockburn, A., & Co. | 47 |
| Cohen, G., Sons & Co., Ld | 48 |
| Coil Clutch Co., Ld | 47 |
| Constable & Co., Ld | 48 |
| Conveyor & Elevator Co. | 7 |
| Coventry Victor Motor Co. | 36 |
| Crossley Brothers, Ld. | 11 |
| Danks, H. & T. (Netherton) Ld | 1 |
| Davey, Paxman & Co., Ld. | 24 |
| Davidson & Co., Ld | 35 |
| Davies & Metcalfe, Ld | 34 |
| Davy Bros., Ld | 44 |
| Dawson & Downie, Ld | 28 |
| De Bergue & Co., Ld | 25 |
| Delta Metal Co., Ld | 46 |
| Demag, Duisburg (cover) | i |
| Dickinson, F. E. | 22 |
| Douglas, Lawson & Co. | 2 |
| Drayton Regulator & Instrument Co., Ld. | 8 |
| Drum Engineering Co., Ld | 3 |
| East Ferry-road Eng'g. Co. | 41 |
| Easton & Anderson | 29 |
| Eclipse Tool Co. | 42 |
| Ellison, G., Ld. | 29 |
| Empire Engineering Co. | 17 |
| English Steel Corpn., Ld. | 48 |
| Fielding & Platt, Ld | 37 |
| Firth, Thos., & Brown, J., Ld | 16-24 |
| Foster, J., & Sons | 38 |
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| Grieve, J., & Co. | 6 |
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| Hadfields Limited | 24 |
| Hall, J. & E., Ld | 25 |
| Hanworthy Engineering Co Ld | 32 |
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| Hendry, J., Ld. | 44 |
| Herbert, A., Ld | 9-12-13 |
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| Higgs Motors | 14 |
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| Kempe's Engineer's Year Book | 43 |
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| Pitman, Sir Isaac, & Sons, Ld. | 2 |
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| Radford, Son & Squire | 48 |
| Reavell & Co., Ld. | 33 |
| Reddaway, F., & Co., Ld. | 45 |
| Redler Patents | 29 |
| Renold & Coventry Chain Co., Ld. | 19 |
| Revairs, G., Ld. | 35 |
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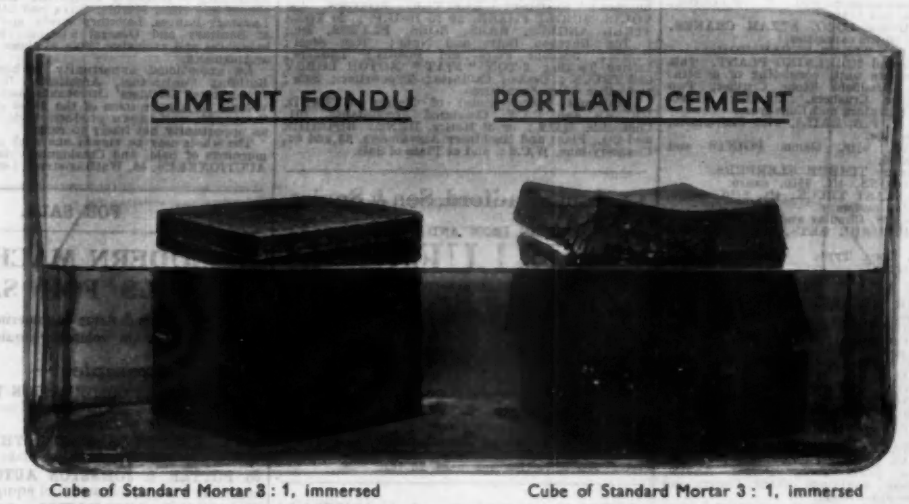


Cube of Standard Mortar 3 : 1, immersed 10th AUGUST, 1931
Photograph taken 30th AUGUST, 1932
Cube of Standard Mortar 3 : 1, immersed 30th JUNE, 1932

POINTS TO BE NOTED

That the Fondu cube, despite its lengthy immersion, is completely unaffected both above and below oil-surface level. That the Portland Cement cube has, in two months, practically lost its cube form owing to the rapid action of the oil. The extraordinary distortion indicates the violence of the disruptive action.

CONCLUSIONS TO BE DRAWN

That Portland Cement is open to exceedingly rapid disintegration when brought into contact with certain oils. Taking the distorted cube, the cement obviously ceased to be of any practical value long before the end of the two months.

That although other more generally-used oils are considerably less violent than cotton-seed oil, the fact that Ciment Fondu has sustained this exceptional attack is convincing proof that it will be equally unaffected by the other oils which destroy Portland Cement.

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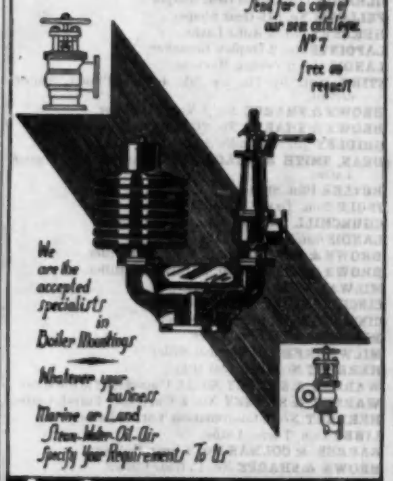

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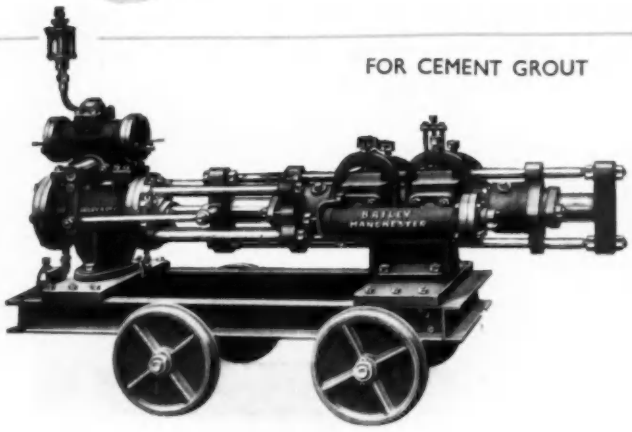

Fig. 6 A D G.—"Davidson" Cement Grout Pump. Driven by compressed air. Used in the construction of the Mersey Tunnel.

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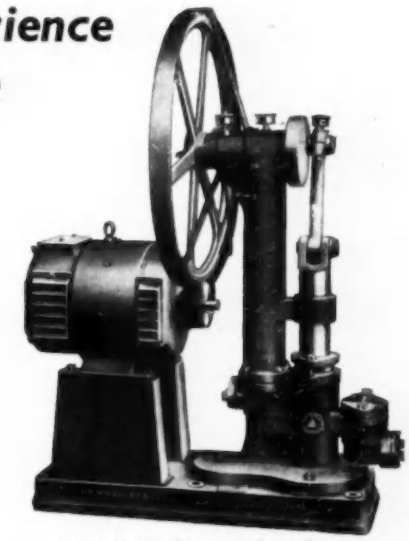

Fig. 160 X.—Electric Ram Pumps.

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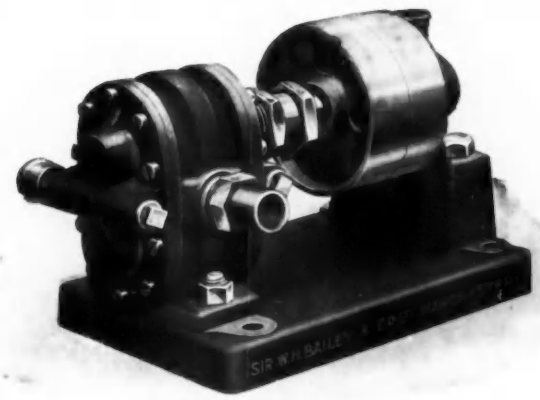

Fig. 7171.—Electric Rotary Pump.

FOR CEMENT GROUT

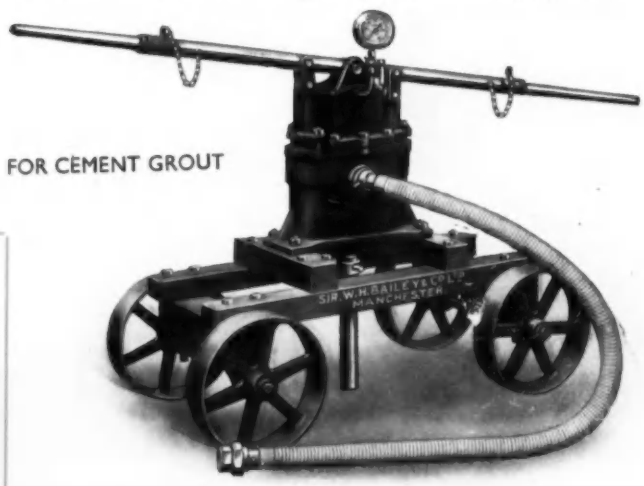

Fig. 7174.—Hand Pump for Cement Grout.

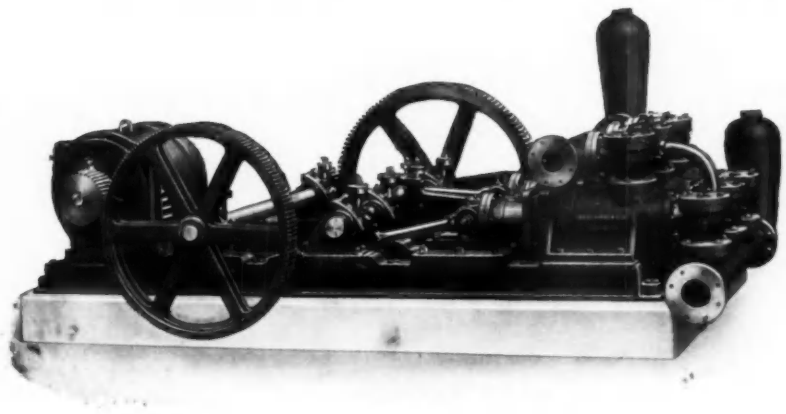

Fig. 7200.—Three Throw Pump. With Electric Drive. For Waterworks, &c., Hydraulic Vessels, &c.

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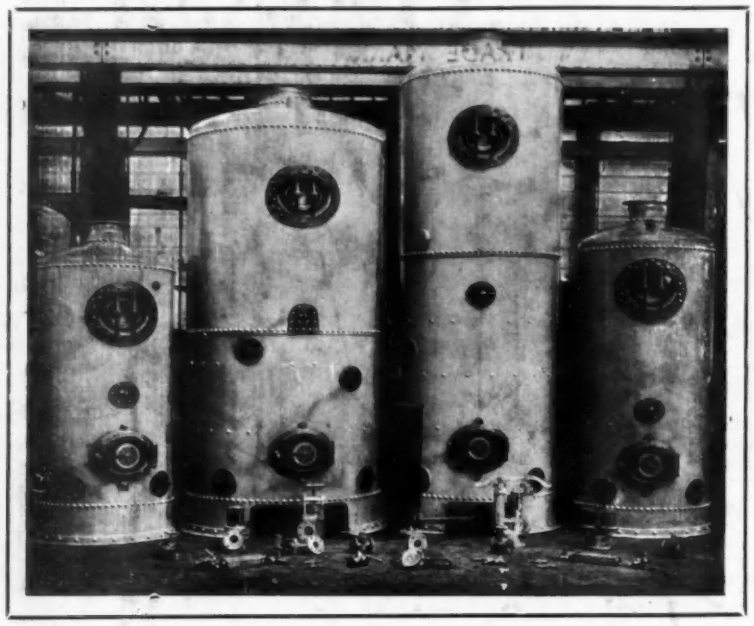

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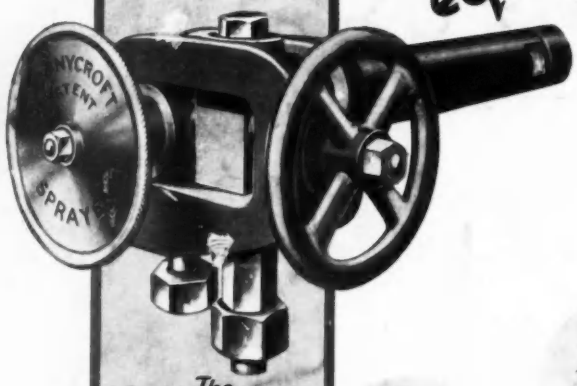


*The Thornycroft patent Oil Fuel Sprayer*

*Note how both edges of exit holes are tangential to the whirling chamber.*

Long experience has proved the simplicity and many advantages of Thornycroft Oil Fuel Gear. Heated oil is sprayed into the furnace under pressure, and the correct mixture of fuel and air to ensure perfect combustion is assured by special patent burners and air cones, without the aid of steam. Complete pulverisation of the oil is effected in the sprayer by both edges of the exit holes being tangential to the whirling chamber. Thornycroft Oil Fuel Gear can easily be fitted to existing boilers and is suitable for all types of steam-raising units. Further particulars obtainable from:

JOHN I. THORNYCROFT & CO., LIMITED, WOOLSTON WORKS, SOUTHAMPTON.

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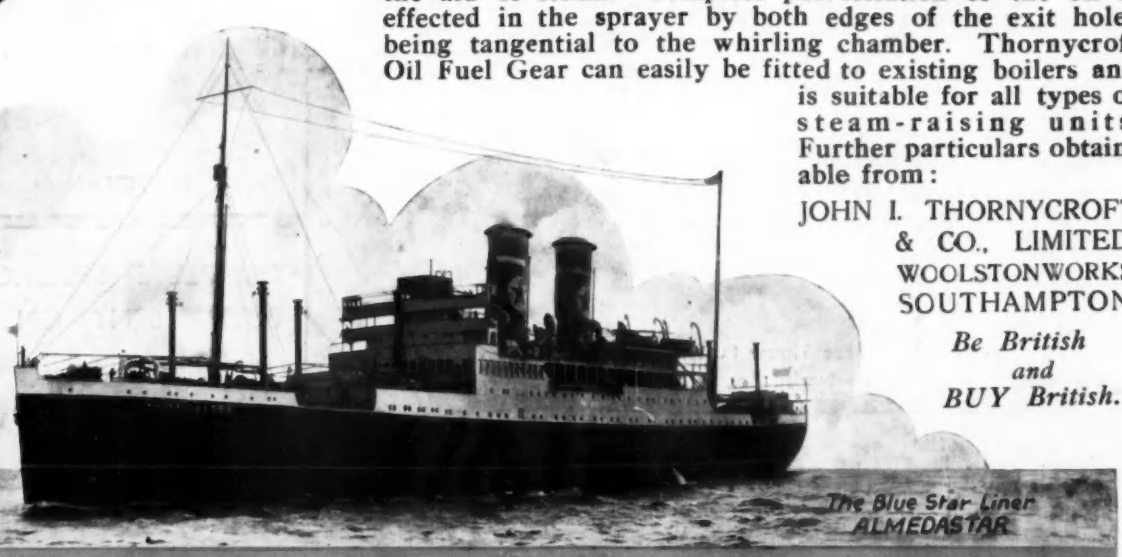

*The Blue Star Liner ALMEDASTAR*